EOLOGICAL NUMBER With "Oil Basins" Map

L AND GAS
URNAL

Uniformity Guaranteed!

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TOOL COMPANY
HOUSTON, TEXAS
WORLD STANDARD
OF THE INDUSTRY

HUGHES Tri-Cone ROCK BITS

Whether you run ten or ten thousand Hughes rock bits, you'll find them uniform in quality and consistent in performance.

The key to this uniformity is Hughes' new method of carburizing and heat treating, employing new automatically controlled equipment and a metallurgical experience gained in 43 years of manufacturing rock bits.*

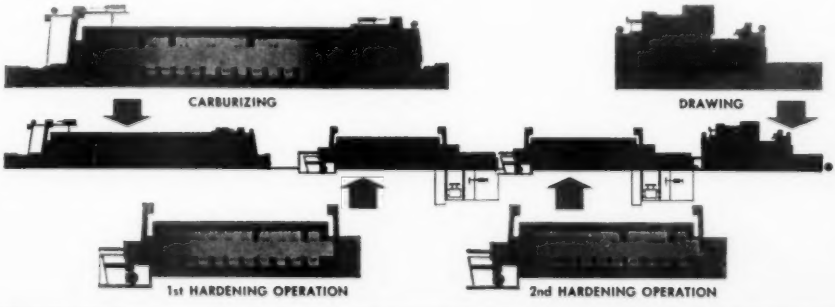
Since 1945, three heat treating furnace lines have been installed. The hardening furnaces in these lines, together with their discharge chambers for quenching, are sealed so that atmosphere as well as temperatures can be controlled.

These new furnace lines permit the desired level of carburization to be set and maintained without variance. The metallurgical characteristics of the case best suited to each size and type of bit is thus assured.

Heat treating – the refining, hardening and drawing of the steel – is done in three stages, each a continuous, automatic operation, in which every step is time-controlled.

Carburizing and heat treating as now done by Hughes, with the latest, most modern equipment available, is your guarantee that the rock bits you get will give the uniform, dependable performance for which they are designed.

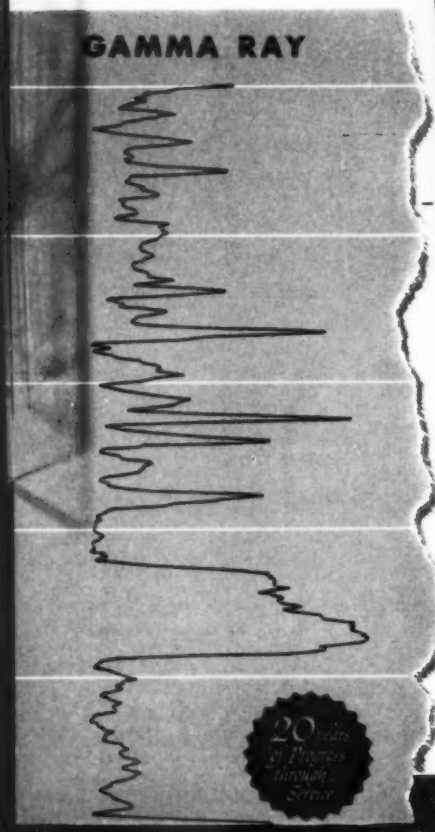
*Hughes Tool Company is the largest deep case carburizer of manufactured products in the world.

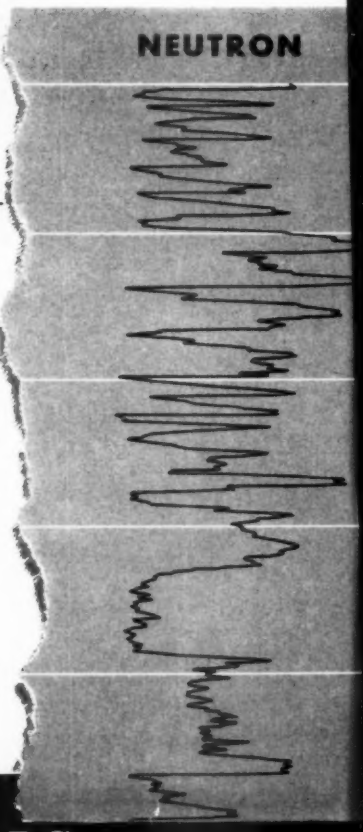


BOILED DOWN—it's as simple as this...

1. THIS CURVE gives an accurate log of the formations through which the well bore passes.

2. THIS CURVE points out where you'll find fluid in the formations.





Put them together

and you have the complete story on your well

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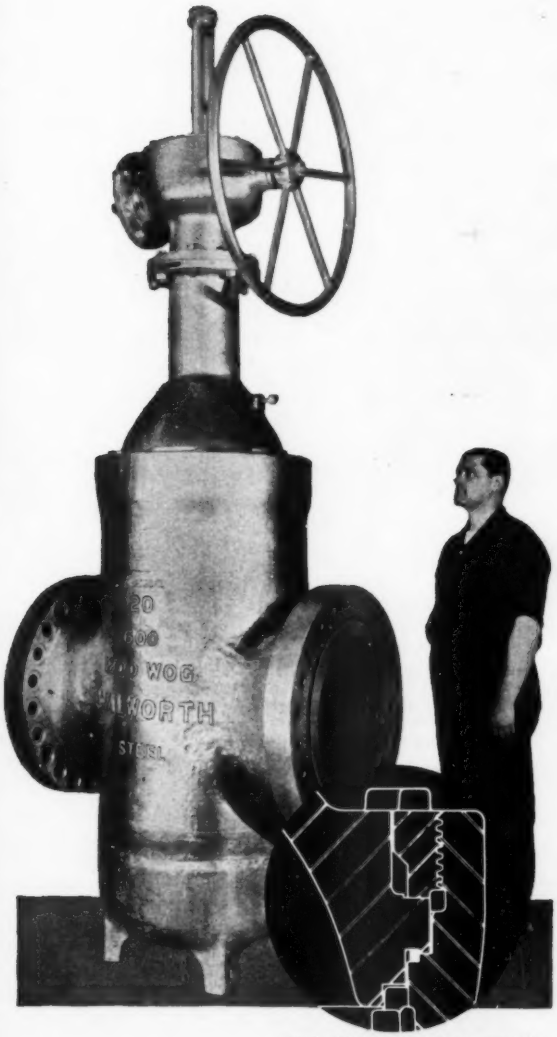
Announcing the New WALWORTH TYPE 49 Steel Pipe Line Gate Valve

(PATENT APPLIED FOR)



Detail of Boltless Body-to-Bonnet Joint

These new Walworth valves have been designed on the through-port principle, with body and disc ports accurately indexed, and body ports bored to match connecting piping. These valves have no recesses to accumulate dirt and no obstructions to interfere with the free flow of liquid or passage of pigs or scrapers. Furthermore, these valves do not require any internal lubrication and may be installed without regard to flow direction. Walworth Type 49 Steel Pipe Line Gate Valves are made in sizes up to and including 30" in Series 400 and 600. Valves have stellite seat rings, and the body-to-bonnet joint incorporates a Walworth boltless design. A detailed illustration of this joint is shown here.

For further information about these new Type 49 Steel Pipe Line Gate Valves, contact your nearest Walworth distributor.

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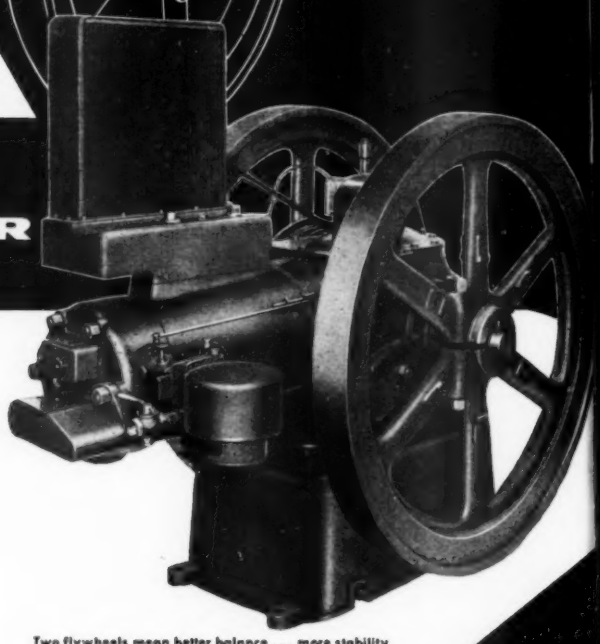
The Oil and Gas Journal, published Mondays, copyright 1952, by The Petroleum Publishing Company. Entered as second-class matter September 1, 1910, at post office at Tulsa, Okla., under act of March 3, 1879. U. S. and foreign rates to the petroleum industry, $4 yearly.

THIS BALANCE ...IS IN YOUR FAVOR



Two flywheels mean better balance . . . more stability on the mounting pedestal. No chance with a "ZC" for unbalanced flywheel effect to cause the engine to work loose from its mounting.

An outstanding performance advantage of the Fairbanks-Morse "ZC" is the *balanced* power output you get with the TWO big flywheels located between the engine and the pumping gear unit. And with TWO flywheels, you can drive from either side of the engine.

Load fluctuations are "smoothed out" by the properly proportioned flywheels, while the power of the engine remains constant. The flywheels store excess energy on the down stroke of the rods . . . then use this stored energy to equalize the load at the peak demand of the up stroke. You not only get smoother pumping . . . you protect engine and driven equipment against overload and abuse.

For the complete story on the "ZC," and the broad range of sizes, see your local supply store or write Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago 5, Ill.

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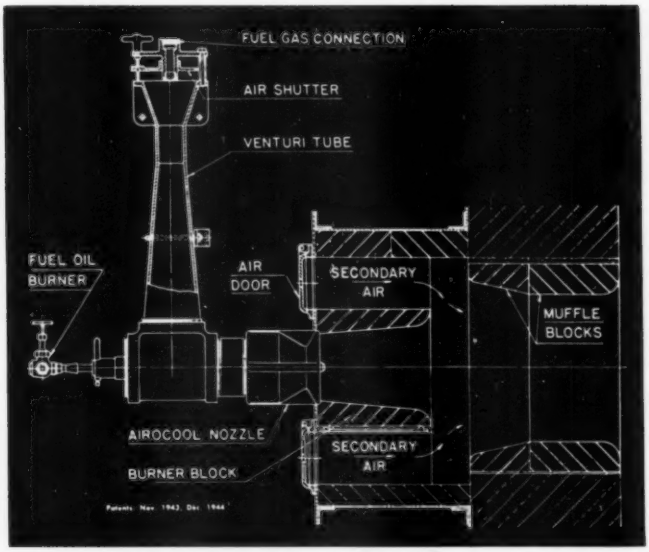

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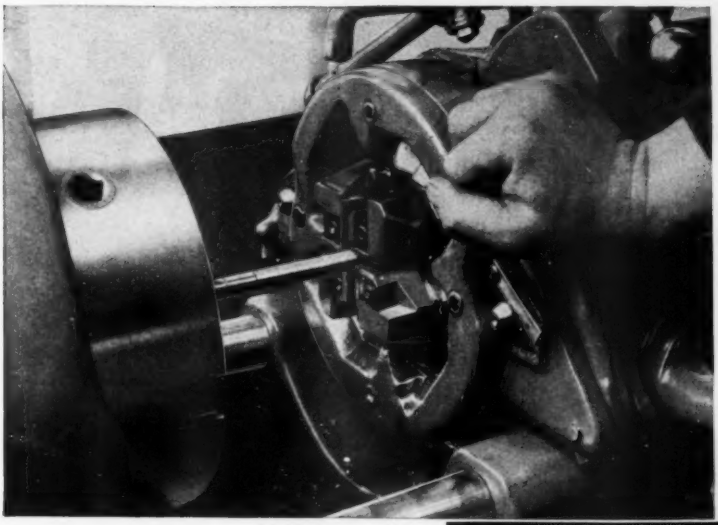
Little Landis

PIPE THREADING & CUTTING MACHINE

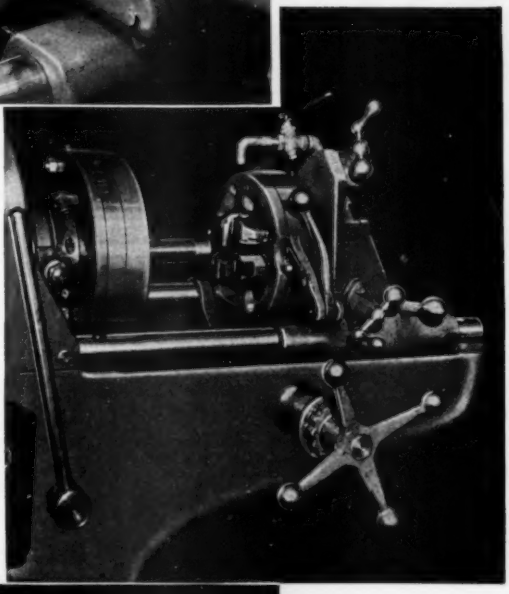


FOR

Maintenance

AND

Jobbing



● The LITTLE LANDIS Pipe Threading and Cutting Machine is designed for threading bolts and for cutting off and threading pipe in jobbing and maintenance shops. In the illustrations on this page, the 2" LITTLE LANDIS is producing bolt threads for use in maintenance work.

The LITTLE LANDIS can handle a variety of work at a minimum cost, permit the quickest possible set-up changes, and produce cleanly-cut and well-formed threads on all materials. It uses the Landis Chaser, the only pipe threading die with the same free-cutting action and natural clearance of a lathe tool. This allows for long life between chaser grindings and smooth finish and accuracy in the finished thread.

Write for Bulletin C-82

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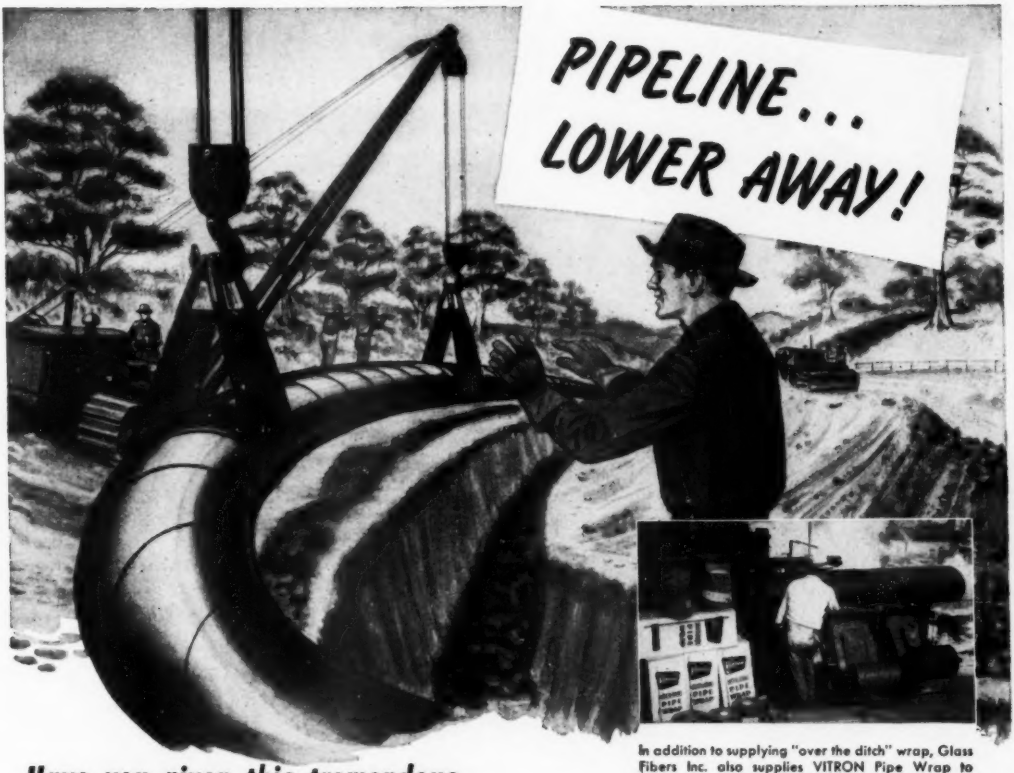

In addition to supplying "over the ditch" wrap, Glass Fibers Inc. also supplies VITRON Pipe Wrap to leading yard wrappers throughout the country in widths to 18 inches and roll lengths to 1,200 feet.

Have you given this tremendous investment the best corrosion insurance?

Into the ground goes an important pipeline—a vital link in the nation's strategic oil and gas supply system.

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Several hundred million square feet of VITRON Underground Pipe Wrap are now in service, reinforcing high grade enamels to provide top quality protection against the greatest enemy of steel pipe—corrosion. Made by the patented electronic-extrusion process developed and used exclusively by Glass Fibers Inc., VITRON Pipe Wrap is parallel reinforced with high strength glass yarns, providing the real strength needed to pull the wrap securely into the coating so it can do the very best reinforcing job.

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UNDERGROUND PIPE WRAP

Write for the facts! A new booklet with test results to show how VITRON Underground Pipe Wrap increases resistance to impact, penetration and absorption, is just off the press. These test findings are vital to everyone who plans, lays or invests in pipelines. Write for your copy today; Address Glass Fibers Inc., 1810 Madison Avenue Toledo 2, Ohio.

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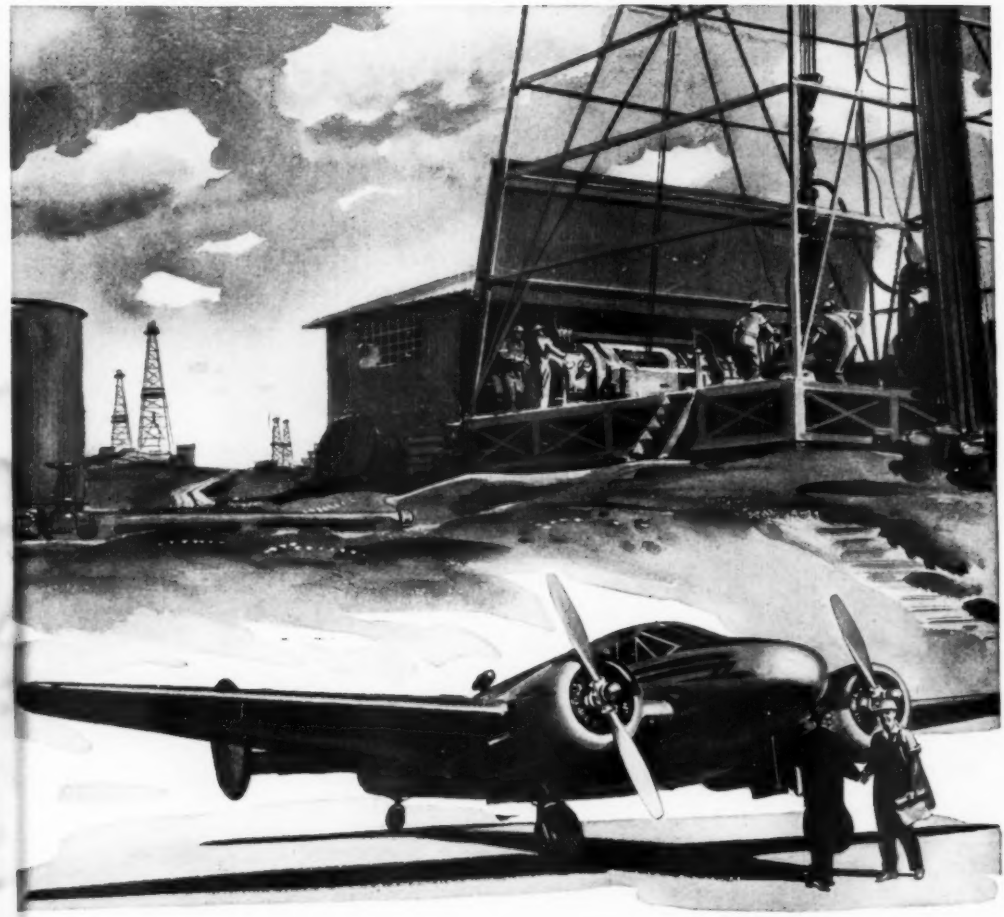
Manufacturers of VITRON Glass Fiber Yarns, Featherweight Wools and Underground Pipe Wrap



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Oil* and Beechcrafts make a profitable mixture!

Company-owned Beechcrafts slice travel time as much as 75% for key executives in over 200 companies in the petroleum industry. This twin-engine Beechcraft Executive Transport cruises at 200 miles per hour — puts oil fields right next to home offices.

***Beechcraft serves 'em all!** In every field of industrial activity, Beechcrafts are helping America build faster . . . helping America do the *double* job of increasing defense production and keeping consumer goods rolling, too. Learn how a Beechcraft can serve *your* business *profitably*. Call your Beechcraft distributor. Or write Beech Aircraft Corporation, Wichita, Kansas, U. S. A.

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FOR heavy-duty dock service requiring a super-sturdy hose, ask the G.T.M.—Goodyear Technical Man—about THOR Oil Suction and Discharge Hose. It's outstanding in flexibility—takes sharp bends without trouble. And THOR combines strength with lightness-per-foot far better than any other hose you can buy.

Ask the G.T.M. for details today, or write Goodyear, Akron 16, Ohio.

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C—Multi-plies of heavy rayon cord for strength and flexibility
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Available in 4", 6", 8" and 10" dia. lengths up to 50' except for 10" aluminum wire hose at 25' maximum.

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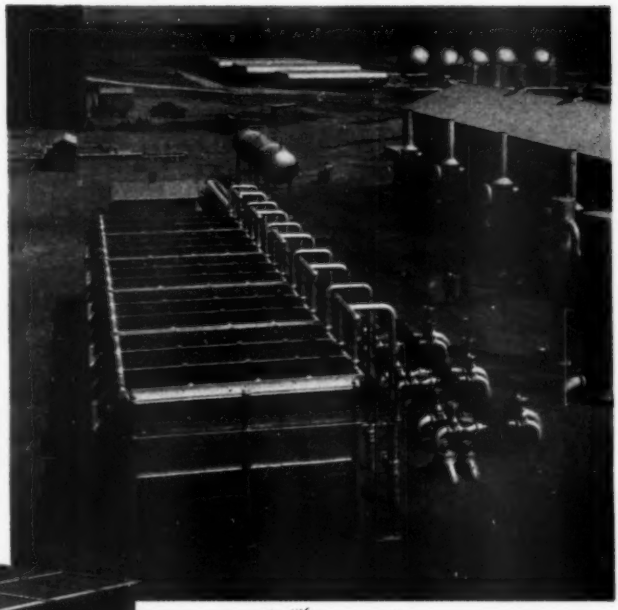
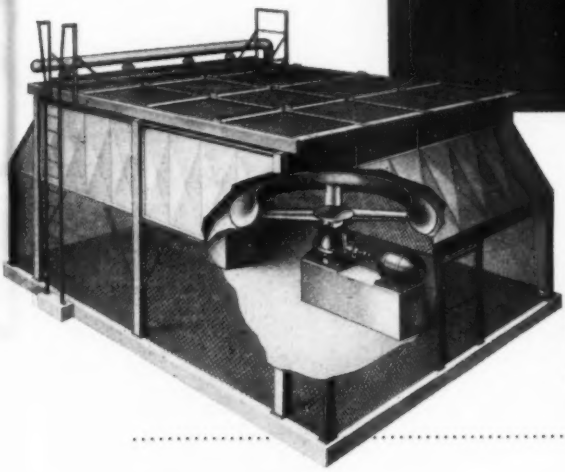
make your own comparison...

a Fluor-GR Fin-Fan

against any other air-cooled heat exchanger

When considering air-cooled heat exchanger equipment, compare the advantages of a Fluor-GR Fin-Fan. Make comparisons of structural simplicity and flexibility. Compare the exclusive features of the Griscom-Russell K-Fin section, the rugged yet precision design of Fluor mechanical equipment. Check *proven performance* in such varied services as gas transmission systems, petroleum refineries, light hydrocarbon processing plants, chemical processing plants, and power and industrial plants. Before you buy or specify, compare the Fluor-GR Fin-Fan. A Fin-Fan provides more exclusive design features —features that add up to *efficient, dependable* performance—than any other make of air-cooled heat exchanger. Write for Fluor Bulletin No. FF-8501.

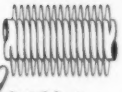




Compare

structural design

Structurally, the Fin-Fan is the ultimate in simplicity and flexibility. Its "truss-type" design provides a rugged, vibrationless unit, free of extraneous parts. Uniform prefabrication of parts, with bolt holes and orientation incorporated in basic design, permits easy extension without shut-down of existing units!



Compare

K-Fin features

G-R K-Fins are tension-wound for moderate temperatures, rolled into grooves for elevated temperatures. Threaded header plugs provide quick, easy access to tube ends for cleaning or replacement. Plugs are shoulder-tight to form a leakproof metal-to-metal joint at all pressures, independent of thread tightness.

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proven performance

More Fluor-GR Fin-Fan Air-Cooled Heat Exchangers are in service throughout the continental United States and in countries abroad than any other make. More Fluor-GR Fin-Fan installations are the result of repeat orders than any other type. Check with your nearest Fluor Representative for the Fin-Fan's outstanding record of proven performance—in services and duties similar to your own!

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STOP RUST! with RUST-OLEUM

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We'll be happy to show you convincing proof that RUST-OLEUM can cut your maintenance costs . . . and last longer when applied over rusted surfaces. Get the facts, today! Prompt delivery from Industrial Distributor stocks in principal cities in the United States and Canada.

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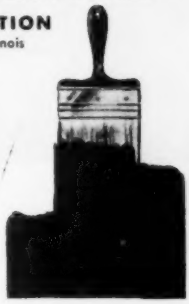
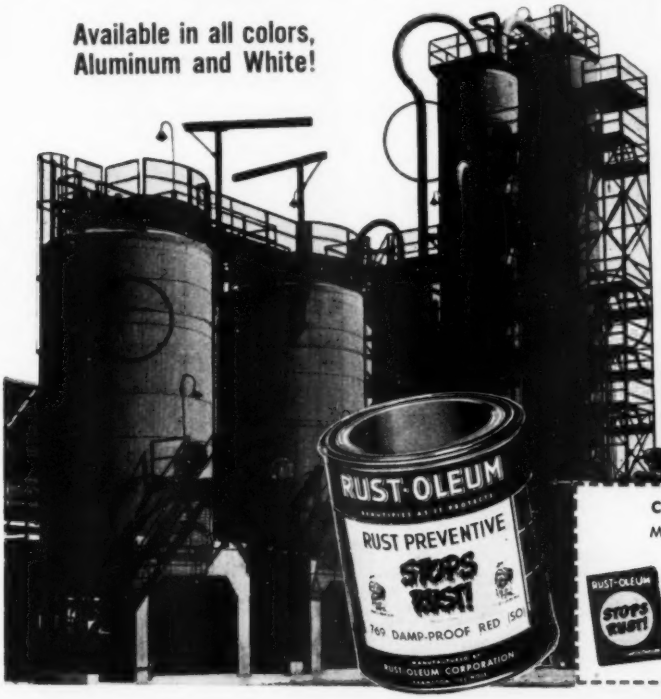


May be applied directly over rusted surfaces without removing all the rust!

Available in all colors, Aluminum and White!



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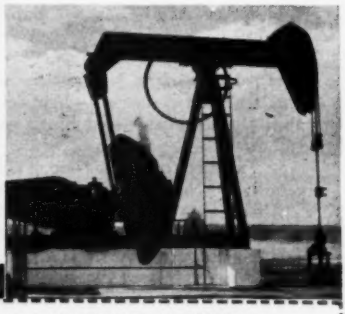

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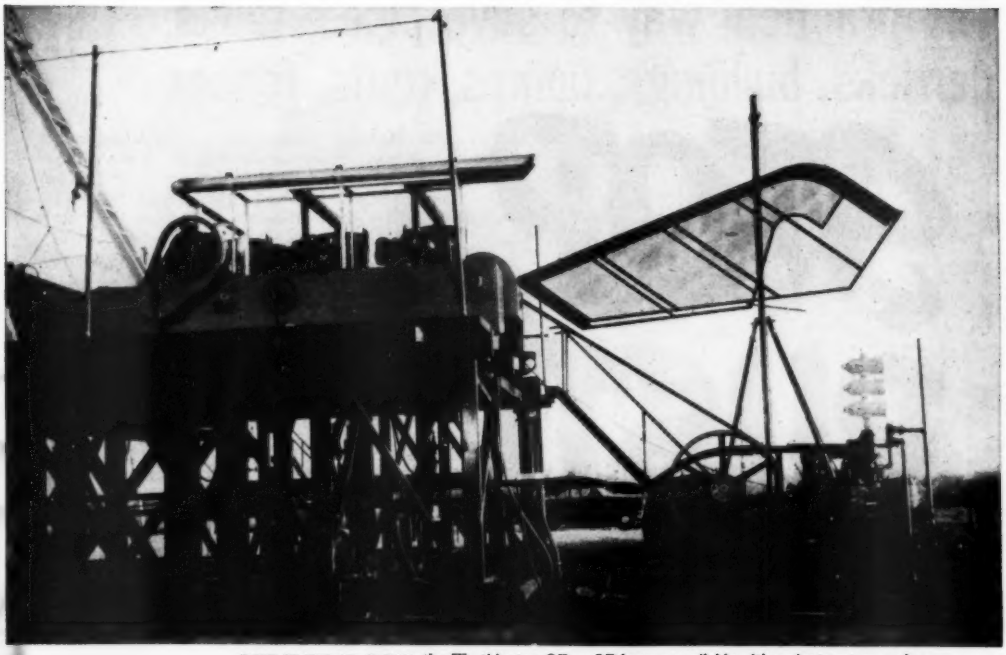


BORN IN THE OIL FIELDS, the Worthington QD sheave is first choice of all industry. Servicing rigs like this one is a much easier job since the QD became available—it's easier to get on, easier to get off, yet always tight on the shaft. And you can get the sizes you need QUICKLY!

We built it to your specifications

Yes, it was the demands of oil production men like you that gave the Worthington QD* sheave its start. Today *all* industries use it. In fact it's the *most widely used* hub-and-rim combination in existence.

Why?

IT'S STRONGER because each size is individually designed for the load it has to carry. Not just *one* standard design for all sizes.

IT'S EASIER TO GET ON—lightweight split hub is clamped to shaft, then heavier taper-bored rim is easily slipped over and press-fitted to hub.

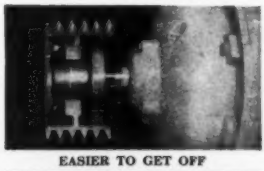
IT'S EASIER TO GET OFF—long pull-up bolts serve as jack screws to remove rim, hub stays put so that there's no realignment problem.

IT'S QUICKLY AVAILABLE—Local distributors in all oil-field areas are stocked-up in most sizes and they're backed up by factory stocks in Los Angeles, Fort Worth, Houston, Tulsa and New Orleans.

IT'LL PAY YOU TO STANDARDIZE on the Worthington QD*. Worthington Pump and Machinery Corporation, Multi-V-Drive Sales Division, Buffalo, N. Y.

*Reg. U. S. Pat. Off.

EASIER TO GET ON



EASIER TO GET OFF

YET ALWAYS TIGHT ON THE SHAFT

MV.2.8

COMPRESSORS: AIR COOLED, WATER COOLED

PUMPS: CENTRIFUGAL, ROTARY, STEAM, POWER

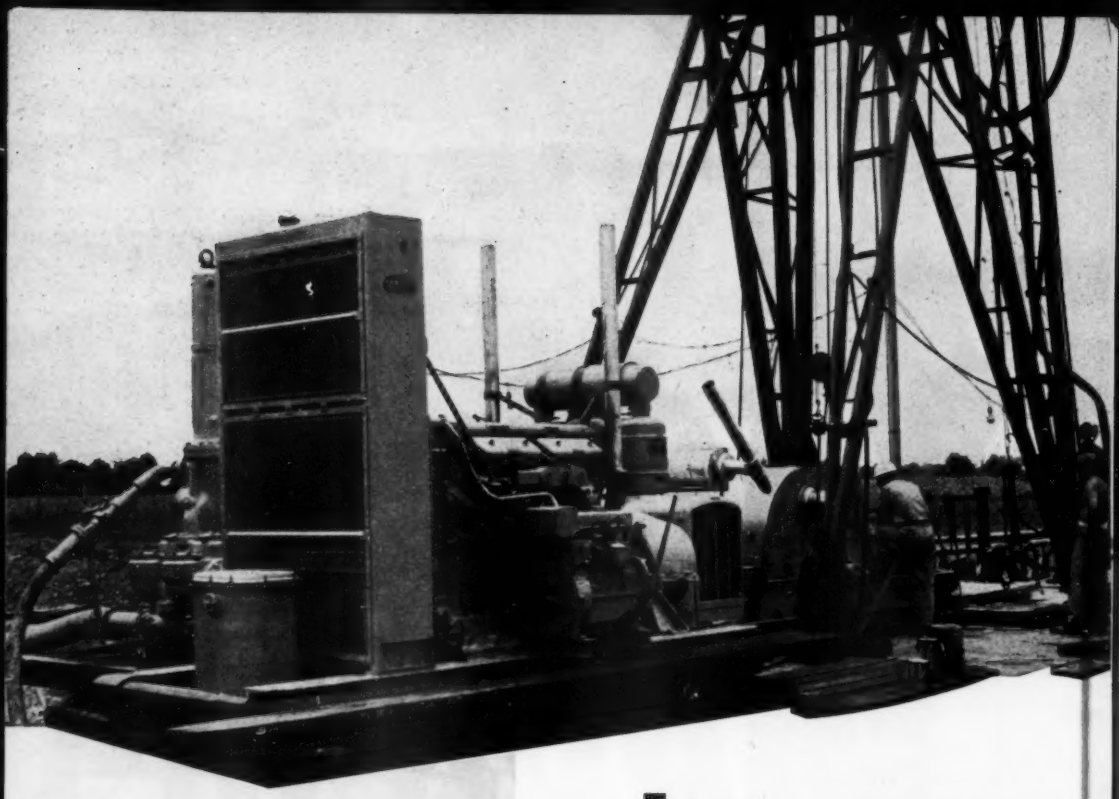
MULTI-V-DRIVES: QD SHEAVES AND V-BELTS

ALLSPEED DRIVES: WORTHINGTON ALLSPEED

WORTHINGTON

Multi-V-Drives

Buy these Worthington standard products from your local distributor



Engineered and built for oilfield duty

THIS big "Caterpillar" D375 Oilfield Engine provides power for the Shulman Brothers' drilling rig near Bible Grove, Illinois. In spite of summer's heat and dust, it can be counted on to deliver steady performance day in and day out.

All sizes of "Caterpillar" Oilfield Engines, like this D375, are designed to stand up under the wide range of stresses found in the world's fields. They are so easy to operate they are practically foolproof. They run efficiently on low-cost fuels without fouling. And they deliver honestly rated power.

High oil production is essential today to our nation's defense economy. Equipment that *stays on the job* helps speed this vital production. "Caterpillar" Oilfield Engines are so strongly built they don't need any coddling, but it's just plain, ordinary common sense to give them proper maintenance care. Just a few minutes' attention a day minimizes the chances of costly down-time and adds to their working life. You can count on complete service from your "Caterpillar" Dealer. Let him help you anticipate your future needs.

CATERPILLAR, PEORIA, ILLINOIS

CATERPILLAR

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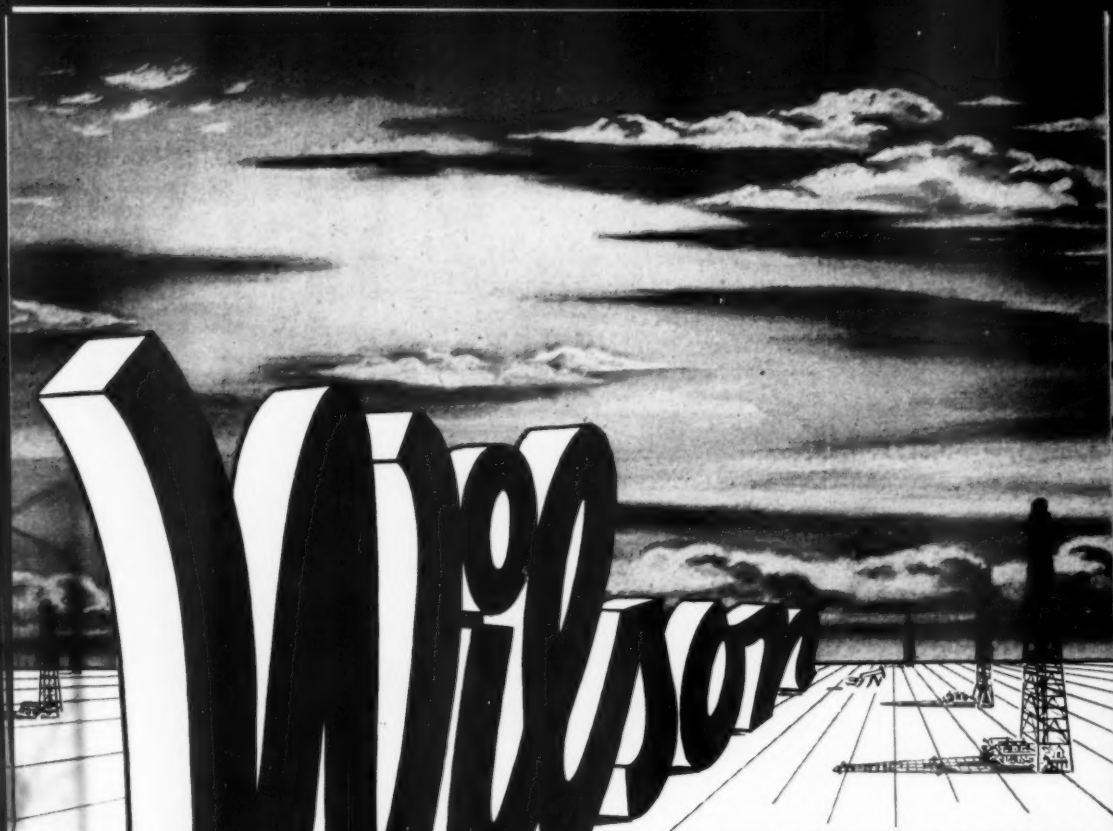
Oilfield Engines



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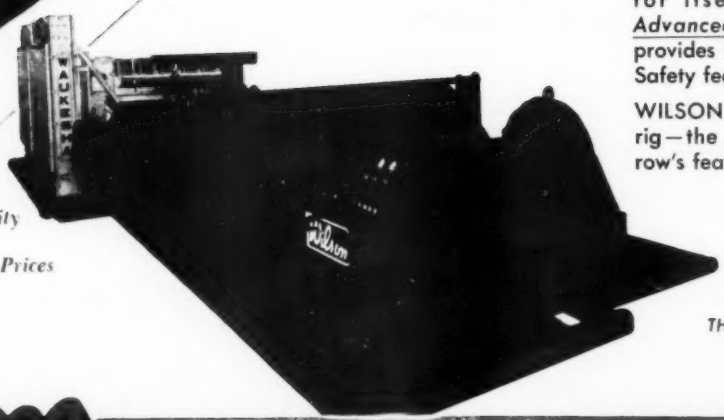
WILSON *Advanced Engineering* — above all else — has kept Wilson the Leader in the Industry.

WILSON *Advanced Engineering* makes it possible for the Contractor to make money in times of high labor and operating costs. WILSON *Advanced Engineering* allows the Contractor to make money many years after the rig has paid for itself. WILSON *Advanced Engineering* provides the maximum in Safety features.

WILSON is the Driller's rig — the rig with tomorrow's features — TODAY!

Compare Quality

Compare Prices



THE NEW WILSON ATLAS RIG

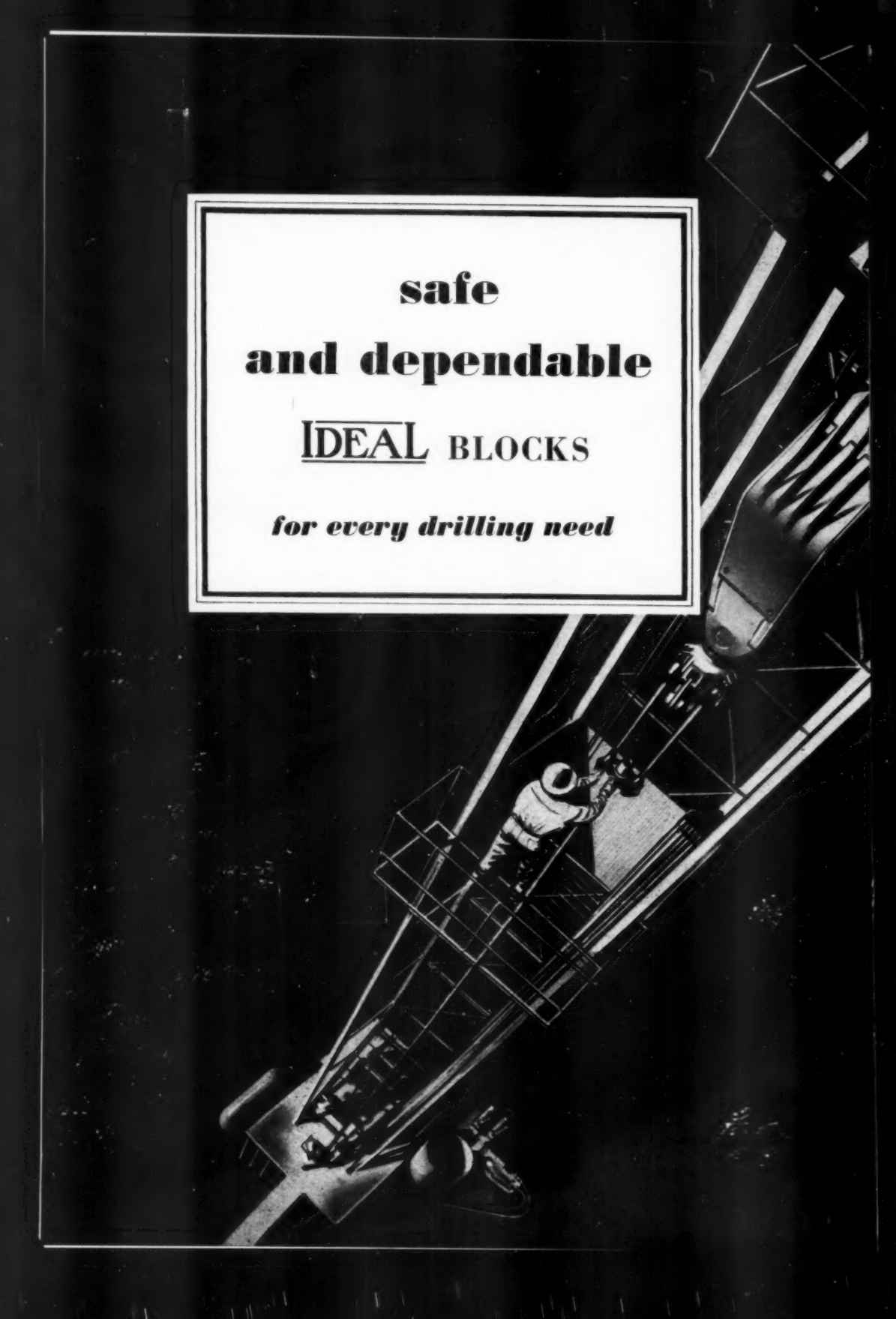
Wilson MANUFACTURING CO., Inc.
WICHITA FALLS, TEXAS

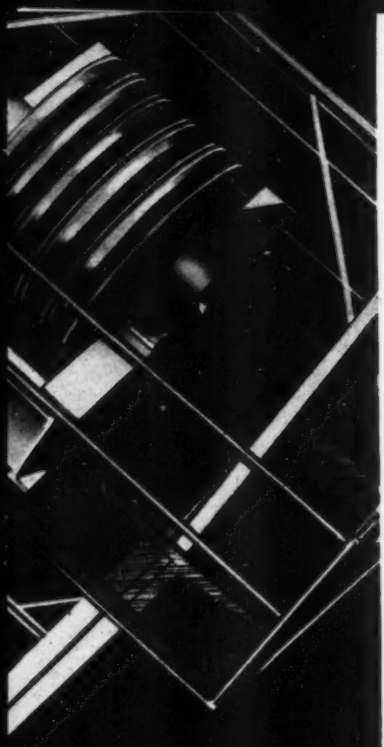
JONES SUCKER RODS

● JONES COUPLINGS are a precision product of the most modern equipment, methods, experience and skill. They are designed, engineered and made to the same high standards as Jones sucker rods. For enduring service from your rod strings—**insist** on Jones couplings, too.

THE S. M. JONES COMPANY
Division of Buffalo-Eclipse Corporation
General Office and Factory: TOLEDO, OHIO
Sales Office: Kennedy Building, Tulsa, Okla.
Export Sales Office: Buffalo International Corp.
50 Church Street, N. Y. C.

LOOK FOR THE GREEN RODS


safe
and dependable
IDEAL BLOCKS
for every drilling need



hook blocks
traveling blocks
connectors
crown blocks

THE complete list of Ideal Derrick Equipment includes a full line of blocks, built to work together and in complete coordination with National Ideal drilling equipment of any capacity.

Six crown block units, rated from 60 to 630 tons, are engineered for service from shallow-well to deepest drilling. Important features of Ideal Crown Blocks include—

- ***bearing design*** **which eliminates side friction and wear.**
- ***lubrication system*** **which serves each bearing individually and seals against water and dust.**
- ***large diameter sheaves*** **accurately grooved for maximum wire line service.**
- ***sand line sheaves,*** **arranged for mounting on crown block frames, available as optional accessories.**

Two types of Ideal Traveling Blocks are included in the six models built for use with Ideal Crown Blocks. In the heavy-duty class are the 300-ton units with five or six sheaves, and the 630-ton unit which employs six sheaves. These Type "T" Blocks utilize separate connectors arranged with eight locking positions for the yoke members.

In the 90-ton to 200-ton class, the new Ideal Hook Blocks combine the flexible features and advantages of traveling blocks, connectors and hooks into a unitized assembly. There are three models in the group, rated at 90 tons, 120 tons and 200 tons respectively.

These new Ideal Hook Blocks are particularly adaptable for drilling operations with portable masts, or in fields where frequent moves require fast action in setting-up and stripping-down. Here are some of the important features of this unitized traveling equipment.

- ***short-coupled assembly*** **which requires minimum vertical derrick space.**
- ***capacity ratings*** **based on strength of maximum diameter wire line.**
- ***streamlined design*** **for maximum safety of personnel and non-interference with fourble.**
- ***large diameter sheaves*** **to match crown block sheave diameters, and increase service-life of wire line.**

The safety and dependability of Ideal Blocks have been time-proved in all types of service where they work together so efficiently with National Ideal Drilling Equipment. Ask for further details at your National Supply Store or write Toledo.

TIONAL OIL FIELD MACHINERY AND EQUIPMENT

SPANG STEEL PIPE

SUPERIOR & ATLAS ENGINES

NATIONAL BLUE PRODUCTS

THE NATIONAL SUPPLY COMPANY

General Sales Offices: Toledo, Ohio

DIVISION OFFICES: Casper; Ft. Worth; Houston; Pittsburgh; Tulsa; Torrance

CANADA: The National Supply Company, Limited, 702 Barron Building, 610 Eighth Avenue, West, Calgary, Alberta

EXPORT: 600 Fifth Avenue, New York 20, N.Y., U.S.A.; River Plate House, 12 South Place, London, E.C.2

IT'S PACKED WITH SATISFACTION WHEN IT'S PACKED WITH **R/M**

In hydraulic systems, as in this hydraulic accumulator ram, and all kinds of fluid-handling equipment, Raybestos-Manhattan Packings and Gaskets are assurance of continuous trouble-free operation. The R/M distributor near you will help you select the right R/M Packings and Gaskets for your valves, pumps, compressors, tanks and other equipment. Call him in.

R/M **PACKINGS**

RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, MANHEIM, PA.

FACTORIES: Bridgeport, Conn., Manheim, Pa.; No. Charleston, S.C.; Crawfordsville, Ind.; Passaic, N.J.; Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC. Manufacturers of Packings • Asbestos Textiles • Mechanical Rubber Products • Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose • Sintered Metal Products • Bowling Balls

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51 YEARS OF PROGRESS WITH THE OIL INDUSTRY

Your own test proves

AMPCO* ALUMINUM BRONZES

Typical Applications in which Ampco Alloys have been used with Cost-Saving Success!

Absorption columns
Acetylators
Acid chain
Agitators
Autoclaves
Baskets
Bearings
Beater bars
Bellows
Bolts and nuts
Brazing rod
Brine coils
Bubble caps and trays
Calandrias
Condenser shells
Condenser tubes
Condenser tube sheets
Control valves
Conveyors
Coolers
Crystallizers
Dephlegmators
Digesters
Ejectors
Evaporators
Evaporator tubes
Extractors
Fabricated assemblies
Filters and filter screens
Filter presses
Fittings — forged, cast
Forgings
Fractionating columns
Hangers
Heat exchangers
Heater coils
Hooks
Injectors
Instrument cases and elements
Kettles
Line hardware
Meter cases
Mixers
Pans, evaporator
Perforated plate
Pickling baskets
Pipe and fittings
Plug cocks
Pressure vessels
Pumps
Reboilers
Retorts
Rivets
Safety tools
Screens
Screws, conveyor
Sludge burners
Springs
Stills
Studs
Sucker rod
Tanks
Tools, safety
Towers
Trays, fractionating
Tubes and tubing
Vats
Valves
Welding rod
Wall tubing
Wire
Woven wire cloth

Chemical Agents and the Applicability of AMPCO Alloys

Acetate Solvents (Pure)	E
Crude	G
Acetic Acid	
Crude	E
Vapors	G
Acetic Anhydride	E
Acetone	E
Acetylene	NR
Alcohols	E
Aluminum Fluoride	G
Aluminum Sulfate	G
Aluminum Hydroxide	E
Ammonia Gas	
Dry	G
Wet	NR
Ammonium Chloride	NR
Ammonium Hydroxide	NR
Ammonium Nitrate	F
Ammonium Phosphate	F
Ammonium Sulfate	F
Amyl Chloride	E
Asphalt	E
Barium Chloride	G
Beer	E
Beet Sugar Liquors	E
Benzene or Benzol	E
Borax	E
Boric Acid	E
Brine	E
Butane, Butylene	E
Butadiene	E
Butyric Acid	E
Calcium Bisulfite	G
Calcium Hydroxide	G
Calcium Hypochlorite	F
Cane Sugar Liquors	E
Carbolic Acid	E
Carbon Dioxide	
Dry	E
Wet	G
Carbon Disulfide	E
Carbon Tetrachloride	E
Caustic Soda	E
Chlorine	
Dry	G
Wet	NR
Chloroform	E
Chromic Acid	NR
Citric Acid	E
Copper Sulfate	NR
Crude Oils — Sour	G
Esters	E
Ethers	E
Ethylene Glycol	E
Ethyl Sulfate	E
Ferric Chloride	NR
Ferric Sulfate	NR
Formaldehyde	E
Formic Acid	E
Freon	E
Furfural	E
Gasoline	E
Gelatine	E
Glucose	E
Glycerine	E
Hydrocarbon Gases	E
Hydrochloric Acid	
to 5%	G
to 10%	F
(see Muriatic)	
Hydrocyanic Acid	NR
Hydrofluoric Acid	G
Hydrogen Fluoride (Dry)	E
Hydrogen	E
Hydrogen Peroxide	F
Hydrogen Sulfide	
Wet	NR
Dry	F
Lacquers and Lacquer Solvents	E
Lactic Acid	E
Magnesium Chloride	G
Magnesium Hydroxide	E
Magnesium Sulfate	E
Malt Beverages	E
Mercuric Chloride	NR
Mine Water (Sulfate)	E
Molasses	E
Monochlorobenzene	E
Muriatic — Cold, Commercial	G
Naptha	E
Natural Gas	E
Nickel Chloride	F
Nickel Sulfate	G
Nitric Acid	NR
Nitrogen (Dry)	E
Oleic Acid	E
Oxygen	E
Paint Vehicles (Except Soya-Oil)	G
Palmitic Acid	E
Petroleum Oils	
Sour	G
Refined	G
Phenol	E
Phosphoric Acid	E
Pickling Acid (except Nitric Chromic)	E
Potassium Chloride	F
Potassium Cyanide	NR
Potassium Hydroxide	F
Potassium Sulfate	E
Potash Crudes	E
Propane	E
Shellac	E
Soaps	E
Soda Ash	
(Sodium Carbonate)	G
Sodium Bicarbonate	E
Sodium Bisulfate	E
Sodium Carbonate	E
Sodium Chloride	E
Sodium Cyanide	NR
Sodium Hydroxide	E
Sodium Nitrate	G
Sodium Perborate	E
Sodium Peroxide	F
Sodium Phosphate	
Alkaline	E
Neutral	G
Acid	E
Sodium Silicate	E
Sodium Sulfate	
(Soda Cake)	E
Sodium Sulfide	NR
Sulfur	F
Sulfur Chloride	NR
Sulfur Dioxide	
Dry	G
Wet	G
Sulfuric Acid	
5%)	E
10%)	E
25%) Up to Boiling	E
35%)	E
50%)	E
Sulfuric Acid Sludge	E
Sulfurous Acid	G
Tannic Acid	E
Tartaric Acid	E
Toluene or Toluol	E
Tri Chlorethylene	E
Tri Sodium Phosphate	E
Turpentine	E
Varnish	E
Vegetable Oils	E
Water	
Fresh	E
Salt (includes Polluted Harbor)	E
Xylene	E
Zinc Chloride	G
Zinc Sulfate	E

These ratings may usually be interpreted as follows:

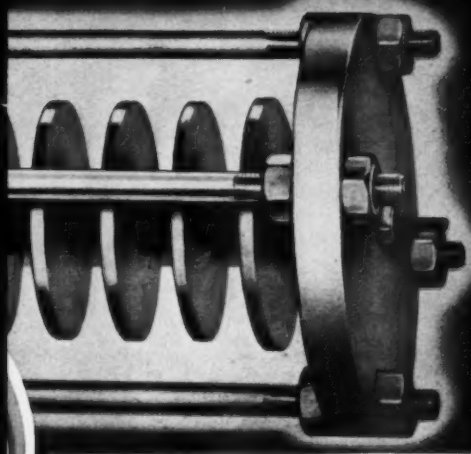
E — Excellent
IPY Penetration <0.006"

G — Good
IPY Penetration <0.016"

F — Fair
IPY Penetration <0.050"

NR — Not Recommended
IPY Penetration Over 0.050"

In using this data, it should be understood that these are results of specific tests and are indicative of those conditions under which the tests were run, and are a basis for recommendation, but not for guarantee.



Fabricating Ampco Metal with Inert Gas Consumable Electrode Welding

are a Practical Remedy for Your Corrosion Ailments

The success of Ampco aluminum bronzes in solving many different corrosion problems for a wide variety of applications is quickly evident from a glance at the tables on the opposite page.

But you may have a special problem of your own. You may want to make your own tests — prove to yourself that Ampco aluminum bronzes offer a money-saving solution.

Here's all you have to do: We have a complete stock of test specimens of different materials which can be mounted on racks. Several forms of racks are available for tests in atmospheric locations, pipe lines, tanks or other pressure vessels. Just write and ask for test specimens, but be sure to outline the conditions under which the test is to be conducted so that we can supply the most suitable form.

Here's another service that can help you. Sometimes repeated 60- to 90-day exposures are required. Our own technicians will work with you through the testing period, pilot plant and preplant operations. Write today.

Ampco Plug Valves

Ampco Bronze Electrodes

Ampco Pipe Fittings

Tear out this coupon and mail today!

*Reg. U. S. Pat. Off.

Ampco Metal, Inc.
Milwaukee 46, Wisconsin
West Coast Plant
Burbank, California

AMPCO

AMPCO METAL, INC., Dept. OG-3, Milwaukee 46, Wisconsin

Send me information on the application of Ampco Aluminum Bronzes for corrosion-resistant service in the Process Industries.

Name..... Title.....

Company.....

Company Address.....

City..... (.....) State.....

PR-6

Nordstrom Merchrome Coated *Mud Line Valve*

After 100,000 feet of drilling at pressures up to 3000 lb

Here is a typical case history of a Nordstrom Merchrome coated mud line valve—

After 100,000 feet of drilling with pressures up to 3000 lb it was disassembled for inspection. As the unretouched picture shows, the plug and body seating surfaces were completely intact. The valve was cleaned and put back into service with no repairs.

Here's another case history—

One 4-inch Fig. 22844 Nordstrom Merchrome coated mud line valve was used in two different Texas fields with 188,984 linear feet of hole drilled and a total of 4953 pumping hours. Then it too was disassembled, cleaned and put back into service without repair.

Nordstrom mud line valves are armored against the destructive action of drilling mud at high pressures. Merchrome hard facing is welded over the entire contact surface of body and plug. Flow is straight through and seats aren't exposed.

The Nordstrom Hypreseal design is built to withstand pressures as high as 5000 lb **WOG** in mud line service.

There's a special Nordstrom Bulletin, V-201, describing Nordstrom Mud Line Valves. Write for your copy.

Rockwell Built Nordstrom Valves

Another ROCKWELL Product

Lubricant Sealed to Keep Upkeep Down

ROCKWELL MANUFACTURING COMPANY
400 N. Lexington Ave., Pittsburgh 8, Pa.

Where FOLDING and FAULTING
make correlation difficult

BAROID
WELL LOGGING SERVICE

Mud Analysis and Cuttings Analysis Combined in One Log, plus On-Location Core Analysis at No Additional Cost!

In areas of disturbed stratification, as in California, where extensive folding and faulting sometimes make sub-surface correlations difficult or impossible, operators have found that Baroid Well Logging Service gives them accurate information just when they need it most — while the bit is digging! And because this down-hole information shows *what* the bit is drilling *while* it is drilling, the hole goes down faster . . . no pulling the string to take cores in barren formation. Only the cores that count need be taken. Faster, more efficient drilling, with assurance that every oil or gas show is detected; these are the reasons why more and more operators are using Baroid Well Logging Service.

Call These Numbers

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New Orleans, La.	TUlane 5165
Corpus Christi, Tex.	3-3262
Midland, Tex.	2-4381
Houston, Tex.	Linden 6381
Tulsa, Okla.	2-8161
Los Angeles, Calif.	Michigan 1381
Casper, Wyoming	2958R
Calgary, Alberta, Canada	2-1316 or 2-1970

Baroid

AJAX IRON WORKS

CORRY, PENNSYLVANIA

Oil Field Distributors THE NATIONAL SUPPLY CO., TOLEDO, OHIO
R. B. MOORE SUPPLY CO., INC., BOLIVAR, N. Y. · BETHLEHEM SUPPLY CO., TULSA, OKLA.

Safety is the primary function of good housekeeping in the petroleum industry. With the Multi-Clean Method it is a simple matter to have concrete floors which provide safe working conditions. They are kept bright and attractive by efficient mechanical maintenance which cleans up dangerous spillage and which provides a safeguard against explosion of air-borne fumes and dust.

The Multi-Clean Method Protects and Beautifies Concrete Floors

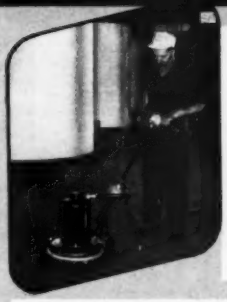
Multi-Clean Concrete Floor Hardener and Etcher conditions the floor surface for the application of Multi-Clean concrete finishes. It cleans, etches and hardens both old and new concrete floors, and prevents them from dusting or staining.

After this etching treatment, either Multi-Clean Neo-Dry Concrete Sealer or Multi-Clean Concrete Preserver are applied to produce a long-lasting finish that is easily cleaned and maintained with a minimum of time and effort. The bonding action of these finishes effectively stops any tendency of the floor to dust or chalk. Available in a wide range of colors, they are easily applied by inexperienced help.

Concrete floors maintained by the Multi-Clean Method are highly resistant to scuffing and wear, and unharmed by water, alkalis, oil and grease. They withstand heavy traffic, and points of exceptionally hard wear are easily touched up without showing lap marks.

Fill in the coupon at the right for your free copy of the Multi-Clean Maintenance Manual for concrete floors. It will show you how to have safer, longer-lasting, more attractive concrete floors, and how to save time and money in their upkeep.

MULTI-CLEAN®
PRODUCTS, INC.



MULTI-CLEAN *Explosion Proof* Floor Machine

New safety and efficiency are combined in the Multi-Clean Explosion Proof Floor Machine, which incorporates an explosion proof motor with other vitally essential safety features. All electrical components of this unit are approved by the Underwriters Laboratory. It quickly and safely eliminates slip hazards by removing grease, oil, chemicals and other dangerous materials.

THE MULTI-CLEAN METHOD OFFERS YOU TWO CONCRETE FLOOR TREATMENTS

Multi-Clean offers two concrete treatments formulated to meet your specific floor requirements. Floors treated with these special products are colorful, attractive, dust free, and easily cleaned and maintained. They are not to be classified as paints, since they penetrate deeply to provide a more durable protective medium.

Multi-Clean Neo-Dry Concrete Sealer is recommended where an extremely fast-drying, highly resistant finish is desired. It is a rubber-base treatment for areas where excessive acid, alkali or grease conditions prevail. It dries so rapidly that two coats may be applied and the floor opened to traffic within two hours if necessary. Multi-Clean Neo-Dry Concrete Sealer is available in Black, White, Green, Tile Red, Gray, Light Gray, Brown, and Natural.

Multi-Clean Concrete Preserver is a special bakelite formulation with high alkaline and traffic resistance. From 8 to 16 hours are required for drying between coats. This finish is very easy to apply. Multi-Clean Concrete Preserver offers outstanding beauty and protection for concrete floors at very nominal cost. Its color range is Tile Red, Maroon, Light Gray, Gray, Green, Brown, and Natural.

Every Multi-Clean Product Carries a 100% Guarantee

MAIL COUPON TODAY FOR FREE MANUAL!

MULTI-CLEAN PRODUCTS, INC.
2277 Ford Parkway, Dept. OG-3, St. Paul 1, Minn.

Gentlemen: Please send Multi-Clean Floor Manuals I have checked.

☐ ASPHALT TILE ☐ CONCRETE ☐ WOOD
☐ RUBBER TILE ☐ TERRAZZO ☐ LINOLEUM

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8-51

BUILDING A GREATER AMERICA

Advance Guard

OR LOOKING AHEAD

Officially, there's no "Travel Bureau" to plan for the safety and comfort of "passengers" like fractionating towers, but Sun Ship workers must plan routes with expert care.

The man who built, in his cellar, a boat too big to go out the window, just didn't look ahead.

The industry that builds a fractionating tower more than 126 feet in length . . . 12 feet inside diameter . . . and weighing more than 180 tons . . . just has to know how to meet the problems of delivering it. Every problem that might be met along hundreds of miles of railway has to be known and planned for.

Knowing clearances and curves, on every foot of railway routes is part of the job. Planning to meet and master those problems, or to select routes which eliminate them, is part of Sun Ship's job when it builds chemical and refinery equipment.

The Sun-built refineries and chemical equipment serving in every part of America and in many foreign lands shows how well Sun men and management have mastered the problems of delivering the equipment they have produced in helping build a greater America.

Sun

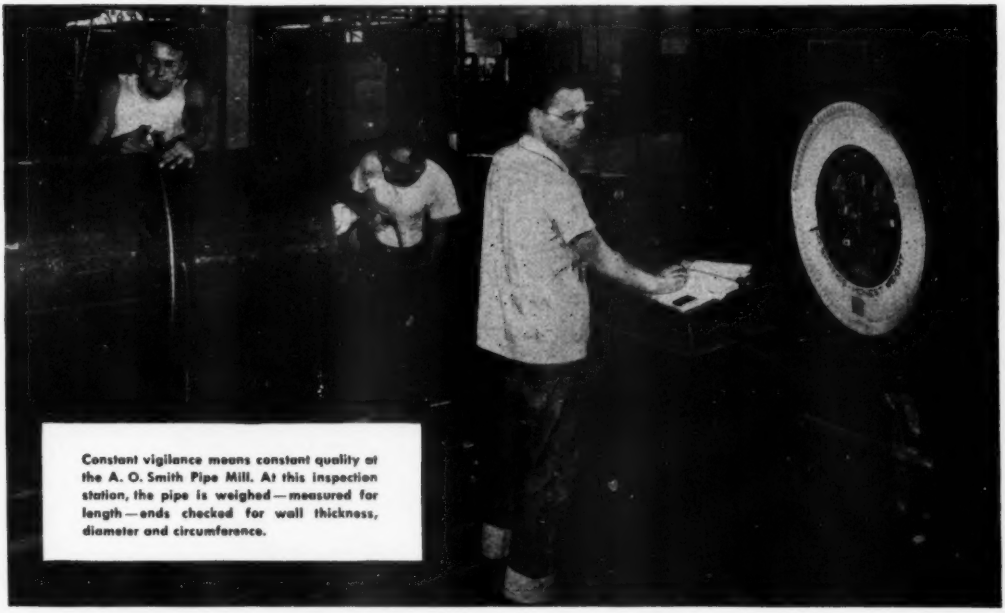
SHIPBUILDING & DRY DOCK COMPANY

SINCE 1916

ON THE DELAWARE • CHESTER, PA.

25 BROADWAY • NEW YORK CITY

FIRST names in pipelines depend on the FIRST* name in line pipe



Constant vigilance means constant quality at the A. O. Smith Pipe Mill. At this inspection station, the pipe is weighed—measured for length—ends checked for wall thickness, diameter and circumference.

A. O. Smith contributes toward lower pipe line installation costs

Uniformity contributes to the quality of the pipe and thus reduces the cost of installation. Uniform, round ends of consistent wall thickness makes for faster lineup in the field—simplifies the welding procedures—reduces total installation time. These are important contributions toward reducing the overall cost of the pipe line—an economic advantage enjoyed by A. O. Smith customers.

To Begin With, plate is used that comes from the mill in uniform thickness and permits careful inspection of both surfaces.

Then our internal expanding process (in use by A. O. Smith for over 20 years) makes certain the pipe is round, straight and of uniform diameter.

Finally complete inspection both during manufacturing process and after finishing makes sure that all pipe shipped meets the high standards established by A. O. Smith.

* **FIRSTS** by A. O. Smith • Welded line pipe • Internal expanded pipe • Light wall large diameter pipe • World's largest producer of large diameter welded steel pipe.

DEPENDABILITY *through* **RESEARCH** *and* **ENGINEERING**

A. O. Smith 78th Anniversary 1874 - 1952

A.O.Smith

LINE PIPE • CASING

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Los Angeles 22 • Midland 5, Texas
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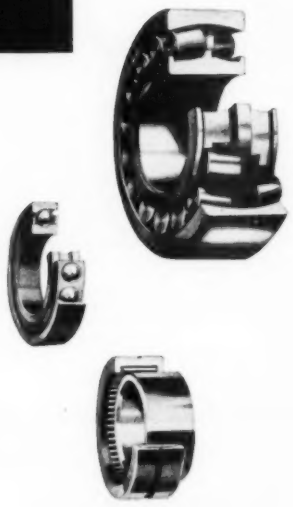
San Francisco 4 • Seattle 1 • International Division: P.O. Box 2023, Milwaukee 1

plan for the best...

If you are seeking more efficient anti-friction performance, you can profit by Torrington's experience and unbiased counsel.

For example, Torrington makes Spherical Roller, Tapered Roller, Straight Roller Bearings and Needle Bearings as well as Ball Bearings and other types. Therefore, our engineers are able to recommend *the* type or combination of types best suited to your design and operating requirements.

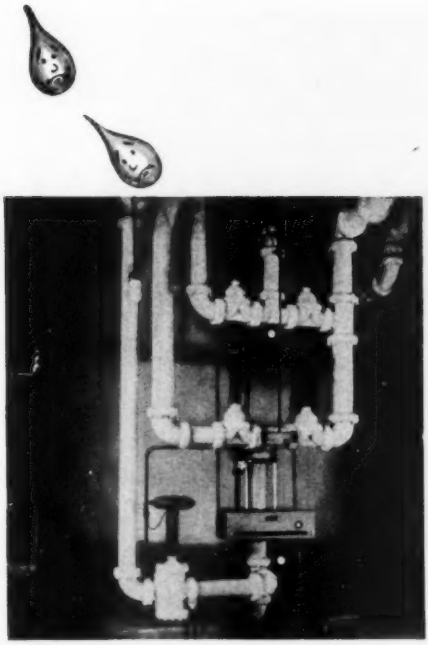
Next time you are planning a new design, call in a Torrington engineer. He will be happy to work with you.



THE TORRINGTON COMPANY
South Bend 21, Ind. Torrington, Conn.
District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON BEARINGS

Spherical Roller • Tapered Roller • Straight Roller • Needle • Ball • Needle Rollers



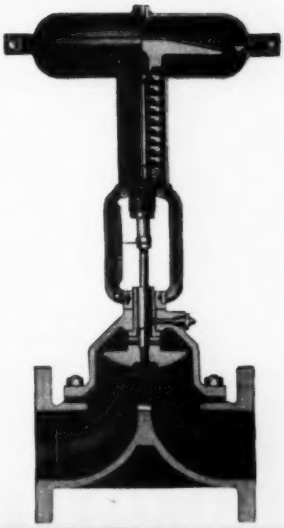
HOW K & M VALVES HELP "SOFTEN UP" 120,000 GALLONS OF HARD WATER PER HOUR

The mineral salts in hard water can cause extremely costly damage to the boilers of a power plant.

At one of America's most important industrial plants, a massive installation of cation and anion exchangers "softens up" or demineralizes water at the rate of 120,000 gallons per hour, thus protecting the steam generators.

The big exchanger units are complicated and require trustworthy regulation of flow at many points. 125 K & M Saunders-Type valves in the assembly do the job with safety, certainty and precision. Moreover, the installation has been so successful that the company is building a similar one, for which K & M valves are also being used.

Leaders in many industries look to K & M valves for proved sensitivity and endurance. K & M is geared to handle the smallest or largest problem in control valves, however exacting the requirements. Our engineers invite your inquiries.



K&M

KIELEY & MUELLER, INC.

Valve Makers Since 1879

2033 - 43rd STREET NORTH BERGEN, N. J.

Four Cleveland Type CU units shown here are at work in a gasoline plant in West Texas. Thousands of this compact, heavy-duty vertical drive are in service in the oil fields and throughout American industry.

Hudson selects CLEVELANDS to drive heat exchanger fans

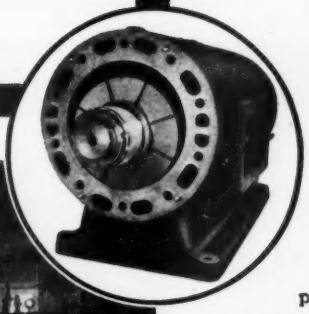
TO drive the fans at a new gasoline plant in West Texas, the Hudson Engineering Corporation selected Cleveland vertical worm gear speed reducers. On this turn-key job, eight CU units were installed to operate gas cooling towers and jacket water coolers to the compressor plant.

The Type CU worm gear drive is designed specifically for cooling tower service. It is a vertical speed reducer built to operate quietly and continuously, at high speeds, for long periods. Extreme conditions of heat and humidity do not affect it. It carries high thrust loads and high radial loads with maximum efficiency. It lends itself to rugged mounting and is easily installed, serviced and adjusted in the field. Every unit is run in and pretested under load before it leaves the factory.

For full description and engineering data, write for Bulletin 135. Free literature for the asking also on other drives in the complete Cleveland line. The Cleveland Worm & Gear Co., 3286 E. 80th St., Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

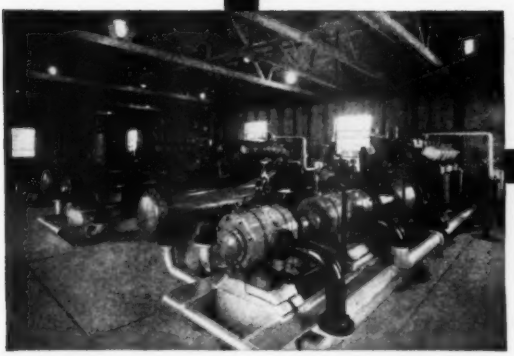
gas gets a better boost



when FULLER gets in the picture

Consider Fuller Rotary Compressors in the over-all picture of your operations. In booster work, whether for field boosting or to trunk line levels, you'll find these compressors doing a better job . . . better because they reduce maintenance cost, cut inspection time, last longer, do the job efficiently.

Pulsing and vibration, valves and complicated parts are eliminated by multi-vane rotary construction. Moving parts are few . . rotor, blades, and bearings. Blades automatically compensate for wear, ***maintaining full capacity for the life of the machine.*** These features explain why Fuller boosters do an outstanding job wherever gas is handled.



If you're interested in getting maximum efficiency and economy into your operational picture, call on a Fuller Engineer. Bulletin C-5 contains a detailed description of Fuller Rotary Compressors. Write for your copy today.

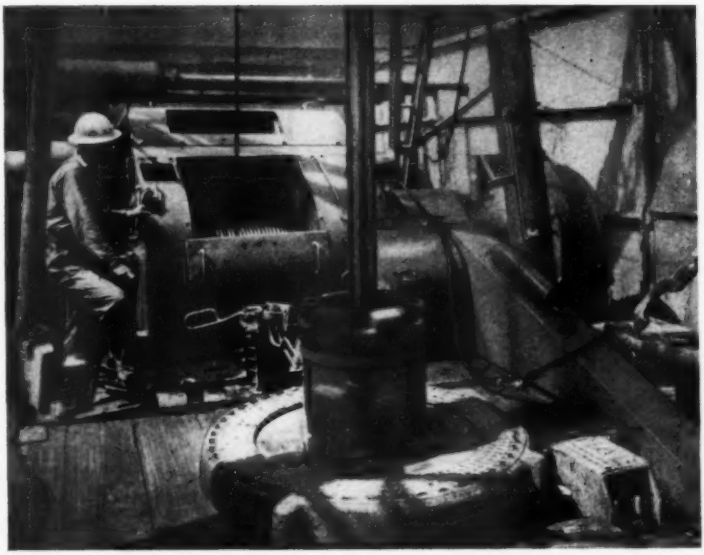
FULLER COMPANY, Catasauqua, Pa.
120 So. LaSalle St., Chicago 3
420 Chancery Bldg., San Francisco 4

Fuller

DRY MATERIAL CONVEYING SYSTEMS AND COOLERS—
COMPRESSORS AND VACUUM PUMPS—
FEEDERS, AND ASSOCIATED EQUIPMENT

C-210

WIRE ROPE



ROEBLING ALL-PURPOSE SLINGS with the Tapered Sleeve Splice come to you ready for the job. They cost less than tucked splices . . . have the full strength of the rope. Send for the full story.

In the oil fields Roebling "Blue Center" Preformed is tops for service and savings

"BLUE CENTER" STEEL wire rope is an exclusive Roebling development. It has to pass the most stringent tests for strength, fatigue and abrasion resistance . . . gives rope the extra long life that spells important economies. Besides, Roebling Preforming assures you top performance on the job. "Blue Center" Preformed is easy to handle . . . has better spooling qualities . . . reduces vibration and whipping.

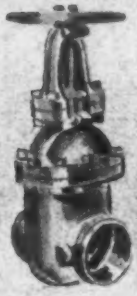
Roebling makes a complete line of wire rope . . . makes the right grade, and construction for every installation. Have your Roebling Field Man help choose the *right* rope for your equipment. Get his advice on the correct use and maintenance of wire rope. It is based on performance records on thousands of installations. John A. Roebling's Sons Company, Trenton 2, New Jersey.

ROEBLING

DISTRIBUTED BY THE NATIONAL SUPPLY COMPANY
REPUBLIC SUPPLY COMPANY

THESE OIL-INDUSTRY STEEL VALVES

Keep Line Pressures High-- Reduce Turbulence



These Lunkenheimer 150 lb. Steel Gate Valves feature smooth interiors and full-rising discs to help you maintain constant pressures by reducing turbulence.

You'll find eleven other advanced design features in these valves—more than in any other steel valve of the same class. See your local Lunkenheimer representative for details.

WRITE FOR

"Lunkenheimer Cast Steels," a 52-page brochure which will help you select the *right* steel valve for any application. Request Circular 506 from The Lunkenheimer Co., Box 360F, Cincinnati 14, O.

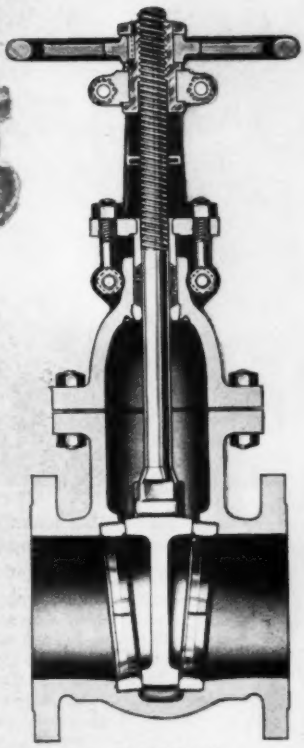


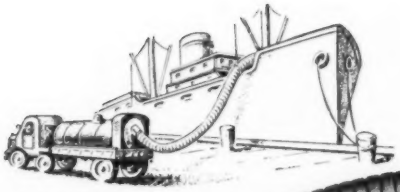
Fig. 1751 WB2
Oil Service

STEEL • IRON • BRONZE

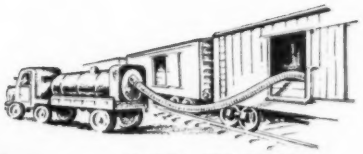
LUNKENHEIMER

THE ONE *Great* NAME IN VALVES

L-652-9



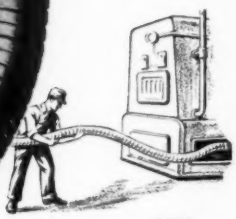
SHIP UNLOADING



GRAIN UNLOADING

INSULATION BLOWING

8" Penflex #20 galvanized steel tubing attached to Sutorbilt blower at Procter & Gamble dock on west coast.



ASH REMOVAL

PENFLEX TAKES THE BITE OUT OF SHARP-TOOTHED CARGOES

PENFLEX FLEXIBLE TUBING MOVES ABRASIVE COPRA—PROVIDES SMOOTH-FLOWING, FLEXIBLE TRANSMISSION—RUGGED RESISTANCE TO WEAR

Unloading abrasive copra is a tough ship-to-shore operation which often spells quick death for conveyor tubing. Jagged chunks of copra eat away ordinary metal tubing—tear rubber hose to shreds.

Wherever "smooth throat" Penflex tubing is on the job, roughest cargoes go down easily. Penflex tubing—tough, smooth and flexible—flows roughest materials evenly . . . eliminates costly clogging and stoppages. And Penflex means flexibility too. Hose moves freely in the hold, absorbs vibration from machines, takes up movement of the ship due to tide changes.

For help with all your tough tubing problems, just call in your Penflex engineer. Penflex makes a complete line of four-wall, interlocked and seamless welded corrugated tubing—from ⅛" I.D. up ...automatic barrel fillers, accessories, fittings, and pneumatic rivet passers. Write for illustrated folder "Flexineering," containing valuable flexible tubing data for your particular product application.

Pennsylvania Flexible Metallic Tubing Company, Inc., 7213 Powers Lane, Phila. 42, Pa.
Branch Sales Offices: **Boston • New York • Chicago • Houston • Cleveland • Los Angeles**

penflex

HEART OF INDUSTRY'S LIFE LINES

How to put HD into premium lubricants

Short-trip, stop-and-go driving, the kind of driving most passenger cars get, results in (1) dirty engines and (2) high engine wear. These, in turn, result in several poor-performance factors easily recognized by motorists — high oil consumption, hydraulic valve lifter sticking, general shortening of engine life.

Monsanto Santolube 382 and Santolube 388 will help give your oils the performance demanded by today's passenger cars. These heavy-duty, detergent-inhibitor type additives help keep engines clean, help reduce engine wear.

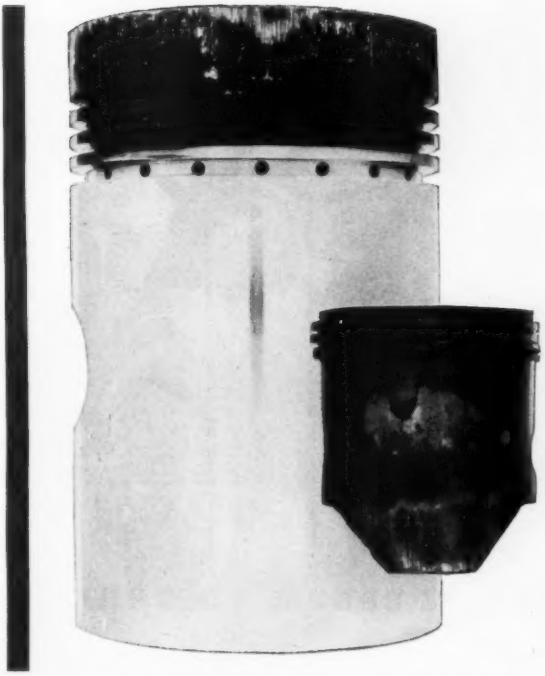
For technical information on these efficient Santolubes, write MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, 1700 South Second Street, St. Louis 4, Missouri.

Santolube: Reg. U. S. Pat. Off.

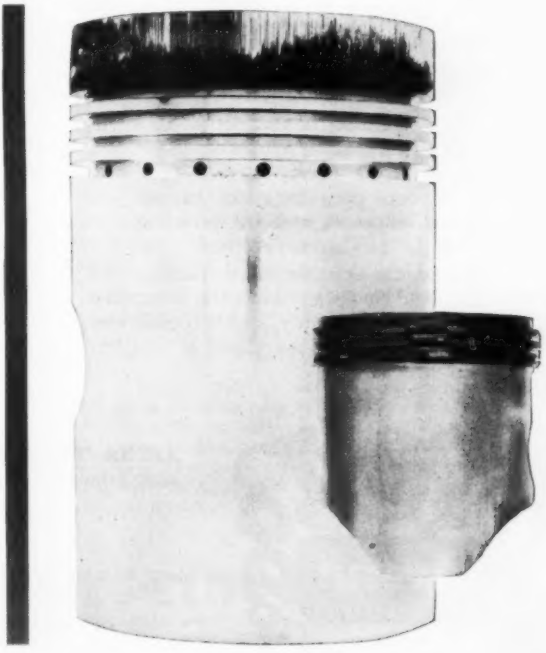
SANTOLUBE

MONSANTO
CHEMICALS – PLASTICS

SERVING INDUSTRY... WHICH SERVES MANKIND



Upper photo shows diesel and passenger car pistons after engine tests with a good grade of motor lubricating oils. Bottom picture shows results of tests on the same oils, plus Monsanto detergent-inhibitor additives.



FOR FREEDOM TO THRIVE

FRICTION MUST STAY THROTTLED

It's a terrifying vision . . . to imagine how swiftly friction, if left unbridled, could bring about the disintegration of our Nation's freedom and economy. But it could happen.

Take, for example, *mental* friction. How long could peaceful minds remain untainted, how long could our liberty survive if America should once drop its guard against subversive influences and fail to succeed in stemming the Communist tide?

Or take, for example, *metal* friction. How long could America produce the things that keep us free and mighty, should friction ever be allowed to freeze the wheels of industry?

Without bearings America would be without hope.

The Aetna Ball and Roller Bearing Company is vigilantly alive to its responsibilities as one of the leading suppliers of the antifriction products so essential to the Nation's vital civilian and military equipment builders. It will continue to direct the results of its best thinking, best experience and best craftsmanship toward further improvements in its service to these indispensable industries. For upon them the security of our nation largely hinges.

Aetna

AETNA BALL AND ROLLER BEARING COMPANY
4600 Schubert Avenue • Chicago 39, Illinois

BALL AND ROLLER BEARINGS • MISCELLANEOUS PRECISION PARTS

Want an oil seal that keeps out abrasives?

In oil field equipment, such as the Lufkin pumping unit (above) Johns-Manville Clipper Seals keep out blow sand and other abrasives that might seriously shorten bearing life. Left: Hammering a Clipper Seal into position. This can be done without harm to the seal, thanks to its tough, one-piece moulded body.

Clipper Seals did the job for Lufkin

One of the design problems Lufkin Foundry & Machine Co. encountered in their oil field pumping equipment was finding an oil seal that would completely exclude blow sand . . . prevent this and other harmful abrasives from entering the cavity and causing damage to bearings. This seal also had to be easy to install, and—equally important—capable of being removed without damage for bearing inspection once the equipment had been "run-in."

It was in Johns-Manville Clipper Seals that Lufkin found the combination of features they needed. Clipper Seals one-piece precision moulded body with its tough, dense heel provides just the right rigidity for a press fit in the cavity. The flexible lip, held in light but positive contact with the shaft by the specially designed garter spring, assures the efficient sealing action needed to keep damaging abrasives out and lubricants in.

And this moulded construction that provides such an effective sealing action also protects the seal against damage during installation and removal. Clipper Seals can be removed and replaced many times without impairing their original sealing efficiency.

Clipper Seals are made in both split and endless types for shafts from ¼″ to 66″ in diameter. A wide choice of lip designs and heel and lip compositions provides the answer to practically any sealing requirement. For further information, write for Brochure PK-46A. Address Johns-Manville, Box 290, New York 16, New York.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville CLIPPER SEALS

SINCE DRAKE DRILLED

In commemoration of almost each of the years since Edwin L. Drake drilled his oil well, the petroleum industry has a Jones & Laughlin Supply store.

Eighty-three of these stores dot the oil fields east from the Rocky Mountain divide, ably supplemented with eighteen sales offices and eight resident salesmen.

Every man who drills wells, or who produces, transports, or refines petroleum products, is cordially invited to use this Jones & Laughlin Supply service—service beyond the dreams of Drake or the expectations of intervening generations.

THIS NATIVE BOULDER MARKS THE SPOT
WHERE THROUGH THE FORESIGHT ENERGY
AND PERSISTENCE OF
EDWIN L. DRAKE
THE FIRST WELL WAS DRILLED FOR OIL
ON AUGUST 27 1859 OIL WAS FOUND
AT A DEPTH OF SIXTY-NINE FEET
THIS GREAT DISCOVERY INAUGURATED THE
PETROLEUM INDUSTRY

Drake monument, between Titusville and Oil City, Pennsylvania. This native boulder marks the spot where the first well was drilled for oil. Completed August 27, 1859, at a depth of 69 feet.

AMERICA NEEDS SCRAP TO MAKE MORE STEEL

Jones & Laughlin Supply Company

EXPORT: 405 Lexington Ave., New York, N. Y., U. S. A.
83 STORES • 18 OFFICES • 8 RESIDENT SALESMEN
General Offices: TULSA, OKLAHOMA

J&L STEEL
Subsidiary of Jones & Laughlin Steel Corporation

STAYNEW FILTERS' DOUBLE ACTION

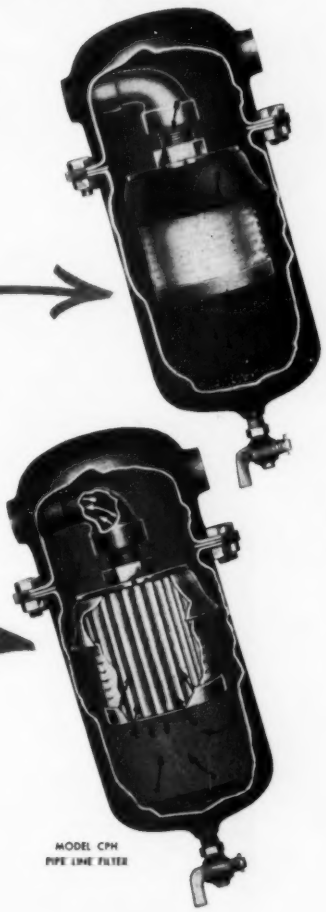
Guards Against Water, Oil and Pipe Scale

MECHANICAL SEPARATION

1. Deflector cup directs flow of air or gas together with water, oil and dirt to the walls of the housing and then downward at high velocity into the base where liquid and heavier dirt particles are deposited.

FILTRATION

2. Air or gas, having been mechanically cleaned, rises at low velocity through the Radial Finned Filtering element or insert which removes the lighter air-borne material.



MODEL CPH
PIPE LINE FILTER

This exclusive Double-Action principle of Staynew Pipe Line Filters assures sustained, trouble-free operation. Inexpensive, quickly installed and easily maintained, these filters keep air operated or controlled equipment free from pipe scale, dust, dirt, and condensate. Wherever you require air and other gases *clean* and *dry*—demand and get—Staynew Pipe Line Filters.

Write today for complete Staynew Pipe Line Filter Bulletin B-1A.

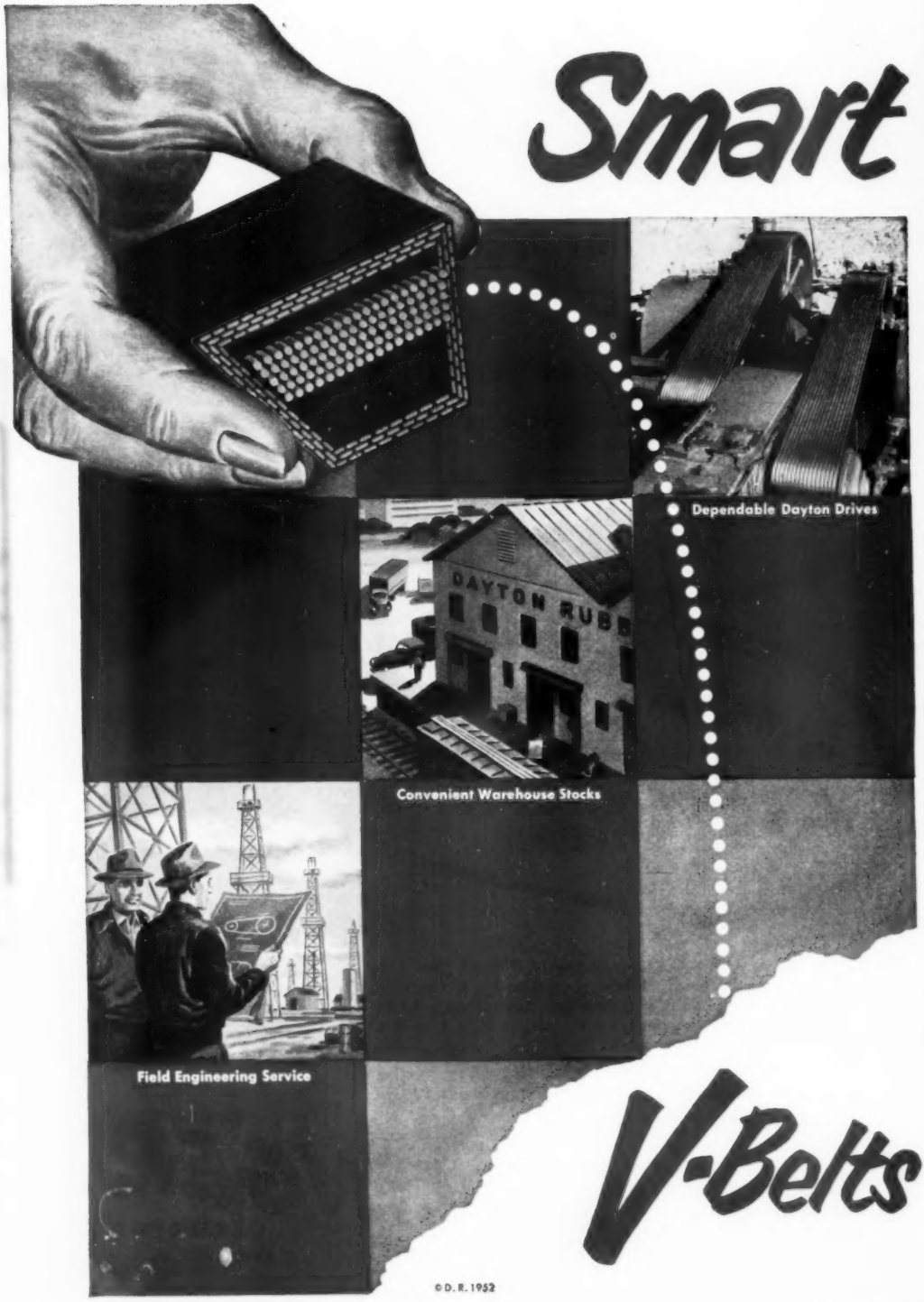
Representatives in Principal Cities

DOLLINGER PROTECTOMOTOR STAYNEW FILTERS

DOLLINGER CORPORATION

5 Centre Pk., Rochester 3, N. Y.

ALL TYPES OF FILTERS FOR EVERY INDUSTRIAL NEED


Smart
Dependable Dayton Drives
DAYTON RUBB
Convenient Warehouse Stocks
Field Engineering Service
V-Belts
©D.R.1952

Move in the OIL FIELD!

There's no doubt about it — one of the wisest moves a drilling superintendent can make is to put Dayton Thorobred V-Belts on his rig. For wherever oil wells are drilled, cost-conscious operators have found that husky Thorobreds are the trouble-free drives for mud pumps . . . rotary . . . every power transmission job.

Why do Dayton Thorobreds give such reliable service in tough applications? Well, a look at the cross section of a Thorobred shows why. See those sturdy cords? They're continuous filament, high tenacity rayon — electronically processed on Dayton's exclusive electronic train. And that rugged cover is made of rubber filled all-weather "Hi-Twist" fabric. No wonder these belts have such a reputation for long life!

Dayton Warehouses provide convenient stocks in all American oil producing centers — and Dayton Oil Field Engineers offer on-the-spot help in clearing up any drilling or pumping drive problem.

Get in touch with the Dayton Distributor or Warehouse in your area. You'll agree it's one of the wisest moves you could make!

DAYTON RUBBER COMPANY, DAYTON 1, OHIO

by Dayton Rubber

Since 1905

WORLD'S LARGEST MANUFACTURER OF V-BELTS

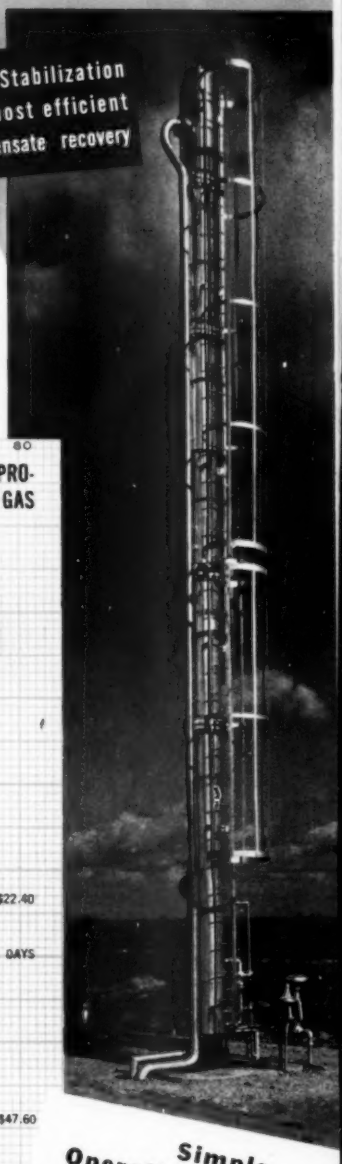
BS&B STABILIZER

PATENT PENDING

So profitable it can pay out in a few months (or weeks)

So simple it can be operated with minimum supervision

Use Stabilization for most efficient condensate recovery



Stabilization is worth considering for any lease with a low temperature separation system producing more than 50 barrels per day. Increase in the use of high recovery methods . . . low temperature separators, and the glycol injection system . . . has created demand for a process that will remove the normally gaseous components for maximum recovery of liquid in the stock tank. The BS&B high-efficiency Stabilizer is the answer to this demand — Available in four standard sizes (12' x 34' . . . 16' x 35' . . . 20' x 44' . . . 24' x 45') for profitable stabilizing of oil or condensate on the lease.

The BS&B High-Efficiency Stabilizer is a vital added step in getting the most revenue out of your oil. It is well known that considerable "shrinkage" occurs in flashing oil or condensate from high-pressure separator to stock tanks.

This shrinkage is due to the vaporization of some of the lighter hydrocarbons which are found in the liquid at high pressures, but vaporize quickly upon a reduction of pressure. Additional lower stages of separation reduce this shrinkage, but this reduction is limited, and normally only one or two additional stages of separation can be justified economically. As the temperature of separation is decreased the amount and percentage of the light volatile hydrocarbons in the liquid is increased. Thus, in low-temperature separation of a condensate well, although stock tank recovery is increased, the actual "shrinkage" from the separator to the stock tank is also increased. By dumping the condensate directly from the high-pressure separator to a BS&B Stabilizer, this shrinkage is reduced to a minimum — all the hydrocarbons which can be maintained at atmospheric temperature and pressure are recovered in the stock tank. Therefore, hundreds of your dollars do not literally "vanish into thin air."

The BS&B Stabilizer prevents this loss in simple fashion. The Stabilizer or distillation column is a tall pressure vessel containing bubble trays. Heat is supplied to the liquid in the bottom of the vessel causing vapors to rise through the column. These vapors are intimately contacted on each bubble tray with cooler descending liquid, the heavier fractions being condensed and the lighter fractions continuing upward. This continuous process of vaporization and condensation allows selective removal of only the lighter hydrocarbons from the liquid. Normally, all methane and ethane and propane are removed overhead and only as much of butane as can be retained in solution with the heavier hydrocarbons at atmospheric temperature and pressure remain in the condensate. All the pentanes and heavier hydrocarbons are recovered. Thus, condensate discharged from the stabilizer to stock (after being cooled to atmospheric temperature) is "dead."

Without producing additional reservoir fluid, the BS&B Stabilizer increases stock tank recovery.

0 10 20 30 40 50 60 70 80
BBLS/DAY CONDENSATE BASED ON PRODUCTION OF 2½ MMSCFD OF SALES GAS
(Actual Test Data)
3-STAGE SEPARATION
3-STAGE LOW TEMP. SEPARATION
LTS w STABILIZATION

DAILY INCOME 3-STAGE SEPARATION

2.5 MMSCFD GAS @ 8c/1000	= $ 200.00
58 BBLS/DAY CONDENSATE @ $2.80/BBL	= $ 162.40
TOTAL DAILY REVENUE	= $ 362.40

DAILY INCOME-LTS

2.5 MMSCFD GAS @ 8c/1000	= $ 200.00
66 BBLS/DAY CONDENSATE @ $2.80/BBL	= $ 184.80
TOTAL DAILY REVENUE	= $ 384.80
ADDED DAILY REVENUE FROM LTS OVER 3-STAGE SEPARATION	= $ 384.80 — $362.40 = $22.40
APPROX. ADDED INITIAL COST OVER 3-STAGE SEPARATION	= $ 5,000.00
GROSS PAY-OUT TIME	= $ 5,000.00 / $ 22.40 = 224 DAYS

DAILY INCOME-LTS WITH STABILIZATION

2.5 MMSCFD GAS @ 8c/1000	= $ 200.00
75 BBLS/DAY CONDENSATE @ $2.80/BBL	= $ 210.00
TOTAL DAILY REVENUE	= $ 410.00
ADDED DAILY REVENUE OVER 3-STAGE SEPARATION	= $ 410.10 — $362.40 = $47.60
APPROX. ADDED INITIAL COST OVER 3-STAGE SEPARATION	= $11,000.00
GROSS PAY-OUT TIME	= $11,000.00 / $ 47.60 = 232 DAYS

Simple Operating Advantag of BS&B STABILIZE

1. All units designed with simplicity controls to permit easy operation an trouble-free performance.
2. Completely automatic.
3. Safe indirect-fired salt bath reboiler.

EFFICIENCY BS&B RELIABILITY

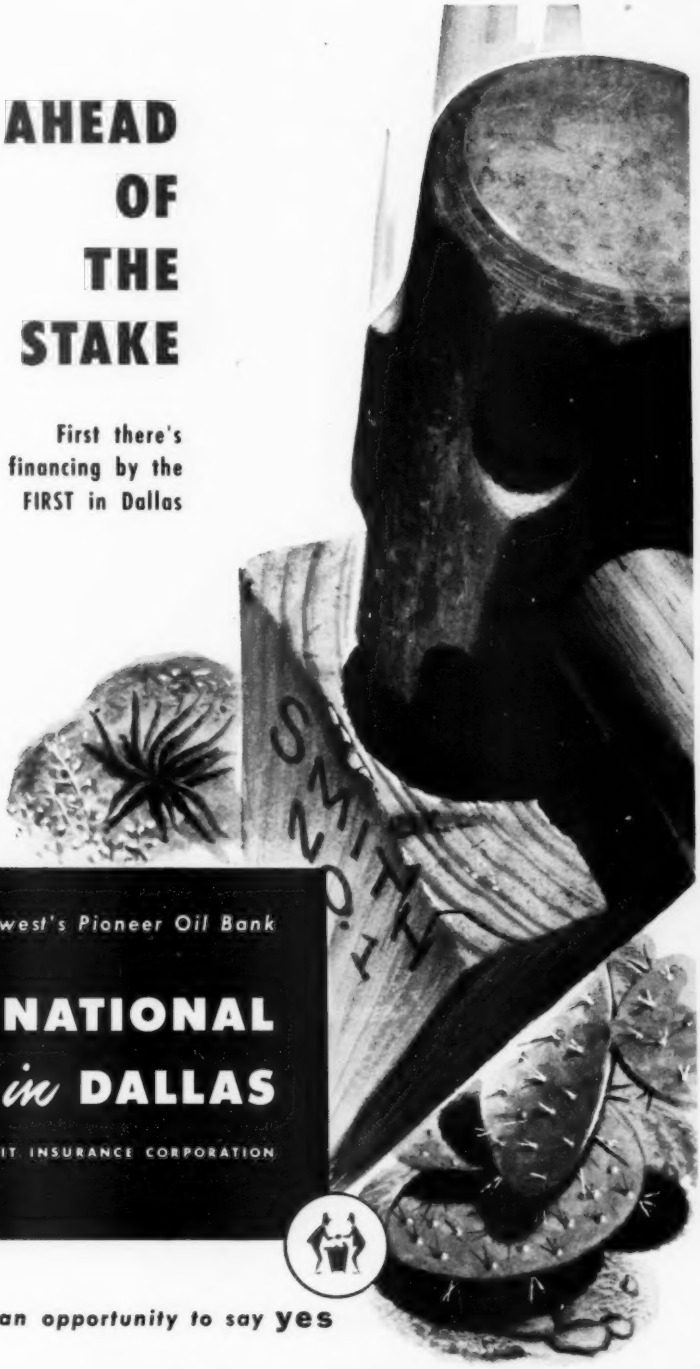
Get complete information now! Write for descriptive bulletin or call your nearest BS&B Service Branch. If you're in the oil country there's one near you.

BLACK, SIVALLS & BRYSON, INC.

OIL AND GAS EQUIPMENT DIVISION, DEPT. 1-A3A
2131 WESTWOOD BLVD., OKLAHOMA CITY, OKLA.

AHEAD OF THE STAKE

First there's financing by the FIRST in Dallas

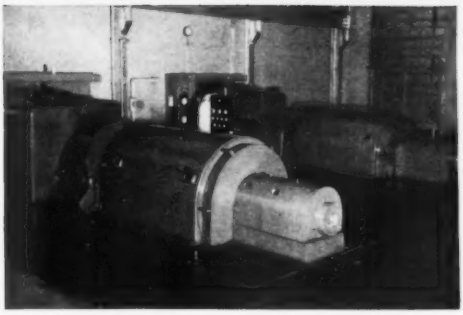


the Southwest's Pioneer Oil Bank

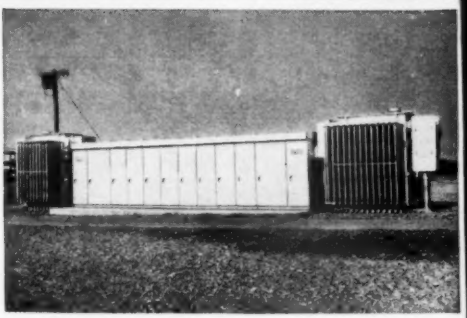
FIRST NATIONAL BANK *in* DALLAS

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

***Give us an opportunity to say* yes**

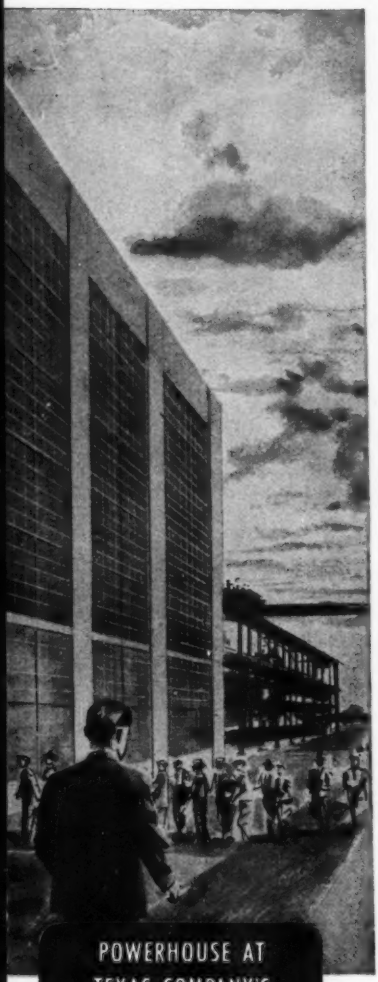


Power is supplied by two Westinghouse Turbine-Generators—plus a stand-by tie-in with utility power. From here, power is sent through *dual feeders* at *high voltage* to substations and load centers throughout the plant.



Each substation is complete with switchgear, transformers and circuit breakers—for redistribution of low-voltage power. This method makes the system highly flexible and dependable and improves voltage regulation.

Here's how *Power System Planning* pays off at Eagle Point Refinery



POWERHOUSE AT TEXAS COMPANY'S NEW EAGLE POINT, N. J., REFINERY

When The Texas Company built their new refinery at Eagle Point, New Jersey, they planned their power system carefully—and had Westinghouse help. They developed a system that's outstanding in dependability . . . in efficiency . . . and in flexibility for future expansion. Here's how they did it.

Refinery has two sources of power

Power is generated by two dependable Westinghouse Turbine-Generators (7,500 kw each). There's also a standby tie-in with the local utility—so that in an emergency they can immediately switch to utility power.

Twin power routes through the plant

From the turbines, power is sent to substations and load centers located throughout the plant. Each of these units has a dual feed. If there's trouble on one line, they switch to the other feeder.

Flexible system for easy expansion

This power distribution system is highly flexible. Suppose they want to expand the plant or add new machinery. All they do is add another substation. The rest of the system need not be disturbed.

High-voltage distribution saves money

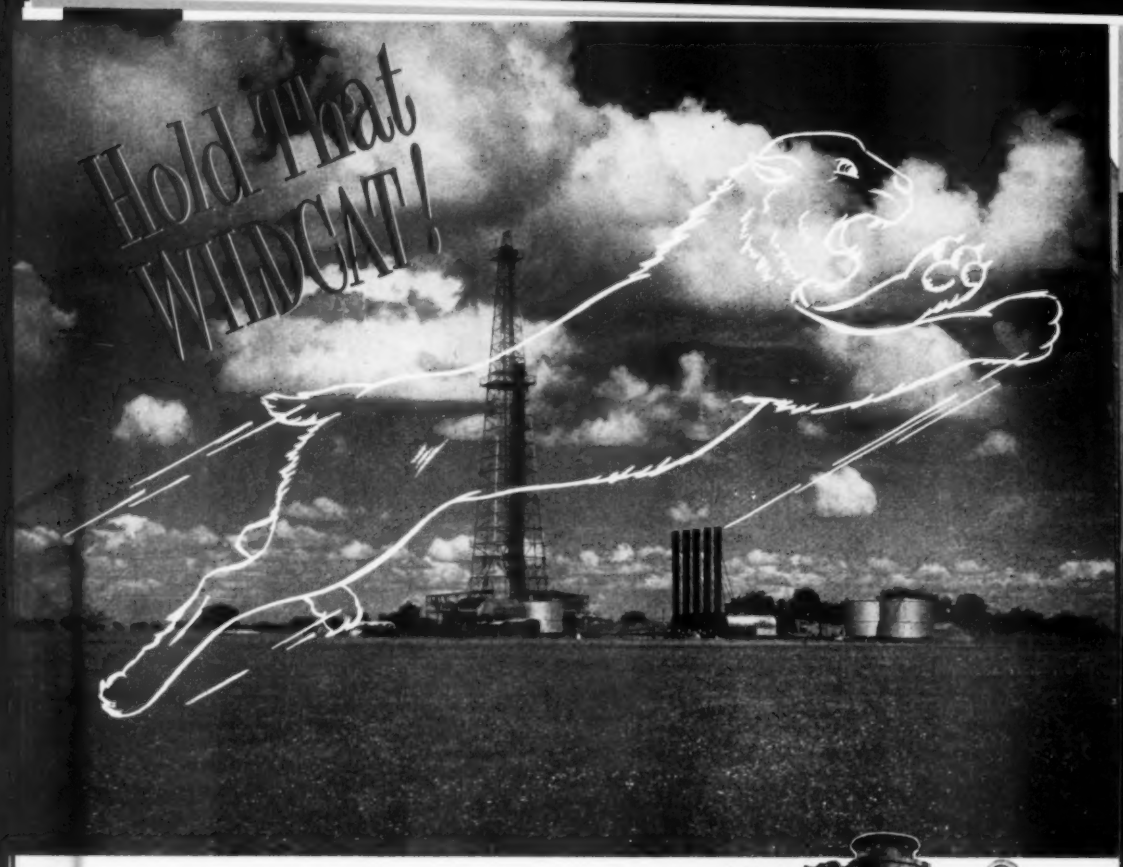
In this modern system, each substation receives power at high voltage (13,800 volts). This cuts down on transmission losses. It improves voltage regulation throughout the plant.

Call in Westinghouse for your refinery needs

Westinghouse has had a great deal of experience in refinery power systems. We'd like to work with you and your engineers on your next project. When you're thinking about building or expanding, call in Westinghouse early. Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pennsylvania. J-94884

YOU CAN BE SURE...IF IT'S Westinghouse

EQUIPMENT FOR THE PETROLEUM INDUSTRY



Next time you rig up on a wildcat, put a ***complete*** Cameron Drilling Control Manifold under your derrick floor.

No other drilling control units offer so much protection: Swift closure of rams, remote control operating valves within easy reach of the driller, self-feeding ram packing for a positive seal and to permit pipe rotation through closed rams; high ratio of closing pressure to well pressure (1 to 8); utilization of well pressure in closing rams, and quick ram change design which permits changing of largest size rams in a matter of minutes.

Take stock of your drilling control equipment now . . . replace obsolete units to provide maximum protection for your operations.

Cameron

IRON WORKS, INC.

P. O. BOX 1212 HOUSTON, TEXAS

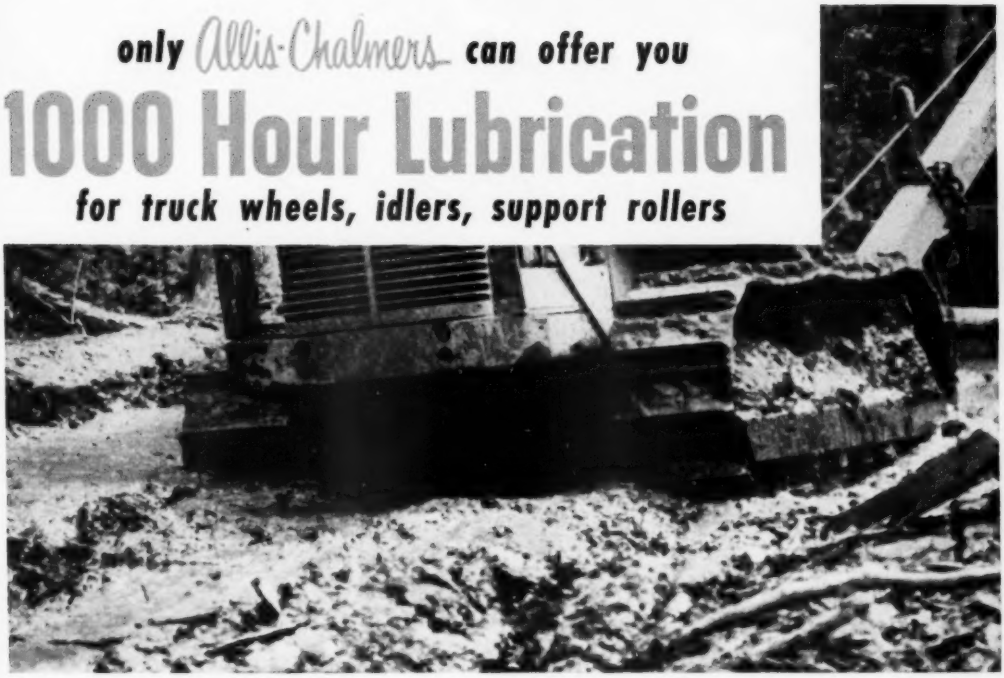
Export Office: 74 Trinity Place, New York, N. Y. Sterling Area: British Oil Field Equipment Co., Ltd., Duke's Court, St. James's, London S.W.1, England. California: Cameron Iron Works of California, Box 267, Long Beach. Canada: Cameron Iron Works of Canada, Ltd., 9860-88th Ave., Suite 3, Edmonton, Alberta.

SELLING THROUGH SUPPLY STORES

only Allis-Chalmers can offer you

1000 Hour Lubrication

for truck wheels, idlers, support rollers



FULL PROTECTION—only One Greasing Every 1000 Hours—with Allis-Chalmers *Exclusive* Positive Seal, Roller Bearing Design. Think of it! You can operate for six months on a 40-hour-week basis with just one lubrication of 14 to 20 of the most-abused, hardest-to-service points on a tractor. It's another ahead-of-the-field design feature found only in the four new Allis-Chalmers tractors.

These Big Benefits Mean DOLLARS to you!

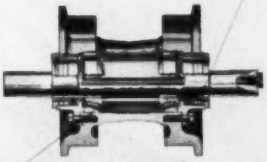
DAILY GREASING PERIODS ELIMINATED. You save at least 30 minutes every day . . . gain about one full month's production every year.

FULL PROTECTION ASSURED. Positive Seals keep grease in . . . dirt and moisture out. 1000-Hour Lubrication gives you protection unchallenged in the tractor field.

EASY TO SERVICE. No more cleaning of dirt, muck and grime from fittings every day. Operator can choose time and place to regrease when conditions are favorable.

Here's the secret:

Positive Seals ground smooth as glass, seal the grease in...keep dirt, grit, dust, mud and water *out*.



Tapered Roller Bearings protect the Positive Seals by letting truck wheels, idlers and support rollers rotate freely . . . without side thrust or wobble.

ALLIS-CHALMERS

TRACTOR DIVISION — MILWAUKEE 1, U. S. A.

the newest finest tractor line on Earth!

- DESIGNED FOR YOUR JOB
- BUILT TO "TAKE IT"
- EASY TO OPERATE
- EASY TO SERVICE

Toughened

FOR EXTRA WEAR...POSITIVE POWER

EXCLUSIVE ATLAS TOUGHENING PROCESS GIVES EXTRA STRENGTH FOR RUGGED SERVICE

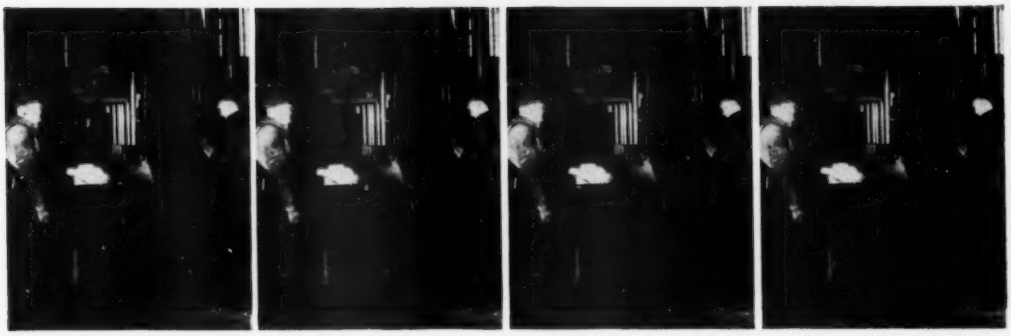
On power transmission drives throughout industry, Atlas "Super Life" Roller Chain is giving extra wear . . . delivering efficient, positive power. Atlas Chain is heat-treated by an exclusive hardening process, which builds in greater strength and wear resistance than conventional hardening. Built to take a beating, Atlas gives long life, maximum service under severest operating conditions.

On all types of machine drives, Atlas Chain transmits power smoothly and efficiently. Positive "no slip" sprocket grip makes possible delivery of full rated horsepower without slippage or friction. For extra wear . . . positive power . . . long trouble-free service, install Atlas on your drives. Write today for new roller chain fact book No. ARC-52OG.

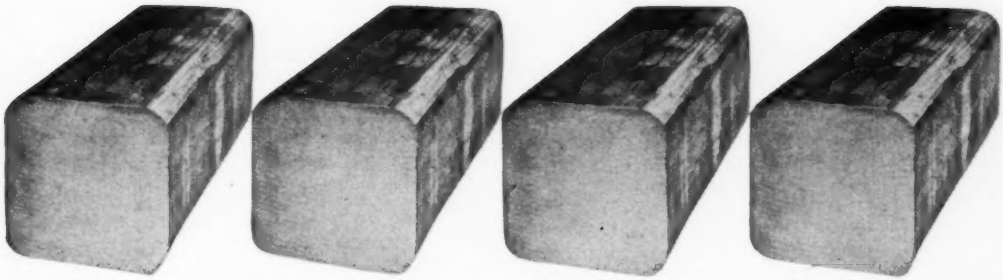
ATLAS CHAIN & MANUFACTURING COMPANY
PHILADELPHIA 24, PENNA.

ATLAS ROLLER CHAIN

To get uniform forgings here...



start with uniform TIMKEN® forging steels!

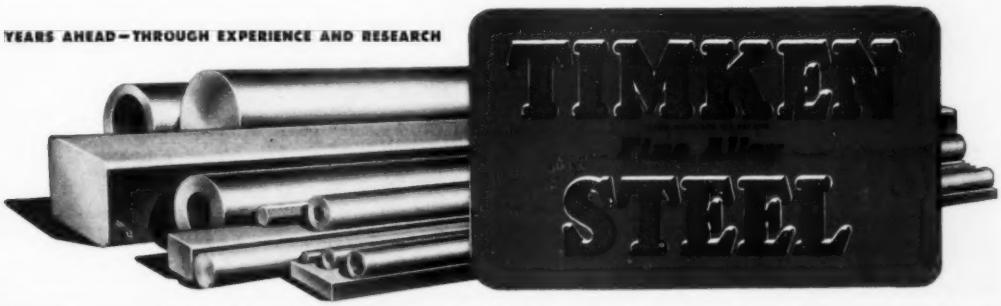


YOU can get uniform, high quality forgings and cut production costs too if you start by using uniform, high quality Timken® forging steels. With Timken forging steels, you're assured of uniform forgeability, uniform response to heat treatment, uniform machinability—from bar to bar and heat to heat. As a result, you have fewer rejects, fewer delays, fewer changes in shop practice.

The uniformity of Timken forging steels is the result of rigid quality control from melt shop through final inspection. For example, the Timken Company uses the direct reading spectrometer—first in the industry—to make possible instantaneous control and checking of every heat before it's tapped.

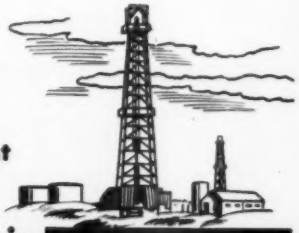
To learn how you can improve the quality of your forgings, cut production costs or both—get an "on-the-job" analysis by our Technical Staff. And for our bulletin No. 31, "Chemical Composition of Alloy Steels", write on your company letterhead to The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH



SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

Save that Well!



When trouble strikes, speed your servicing equipment to any location, in toughest weather and terrain—

with this

WALTER OILFIELD TRACTOR

100% TRACTION IN FOUR WHEELS

•

No spinning wheels

•

No bogging down in mud, sand, soft dirt, snow and up steep grades

LIKE a doctor's emergency call, every minute counts when servicing equipment is urgently needed for a "sick" well. Don't gamble on trucks that slow down or stall in soft or slippery ground.

Fast, mobile Walter Oilfield Tractors get through where other trucks stall. The exclusive Walter 4-Point Positive Drive provides four driving wheels, with 100% positive traction in each. Only the wheels with most traction get the most power, whereas other trucks waste their power on slipping wheels, which spin helplessly.

Other features include a 125 h.p. heavy duty motor; compact 90" wheelbase for maneuverability; large, single 14:00 x 20 tires for extra rolling ability; 16 inch ground clearance; 30-40 m.p.h. on normal roadways. Model shown has 16,000 lb. g.v.w., but other models available up to 36,000 lb. g.v.w.

WALTER MOTOR TRUCK CO., 1001-19 Irving Ave., Ridgewood 27, Queens, L. I., N. Y.

In Canada: Walter Motor Trucks of Canada Ltd., 46 Elgin St., Ottawa, Ontario

WALTER
4-POINT POSITIVE DRIVE
TRACTOR TRUCKS

Haul where others stall

See your nearest distributor

EAST
J. F. Brittain
3001 Glenwood Park Ave., Erie, Pa.
Clyde W. Beckner, Inc.
219 Virginia St., W., Charleston, W. Va.
Dow & Company
1820 Elmwood Ave., Buffalo, N. Y.
Equipment & Supplies, Inc.
624 Grant Bldg., Pittsburgh, Pa.

COLORADO
Western Machinery Co., Denver

ARIZONA
Western Machinery Co., Phoenix

TEXAS
Plains Machinery Co.
P. O. Box 288, Amarillo, Tex.

CALIFORNIA
Edward R. Bacon Co.
17th & Folsom St., San Francisco
Shaw Sales & Service Co.
5100 Anaheim-Telegraph Rd., Los Angeles

ILLINOIS
C. C. Fuller Co.
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OKLAHOMA, ARKANSAS
Diesel Power Company
1801 N.E. 9th St., Oklahoma City, Okla.

LOUISIANA and MISSISSIPPI
Logan Perkins
Int'l. Trade Mart, New Orleans, La.

NEVER AN AXELSON ORPHAN ANYWHERE

When you buy an Axelson deep well plunger pump you are getting the finest equipment that can be made. But, equally important, you have the assurance that this equipment will not become an orphan in the field. Axelson, with its years of service to the Petroleum Industry, has a far flung field organization which affords a ready source for replacement parts, and Axelson experts fully capable of handling any special problems which might arise in the field.

• Buy Axelson products from Axelson sales offices, field stores, direct representatives and authorized distributors in all principal oil fields, both foreign and domestic.

Write on your letterhead for an Axelson Production Calculator.

Axelson "TLE" [Tubing Liner] Pump shown. There is an Axelson Deep Well Plunger Pump for every specific well condition.

AXELSON

PETROLEUM PUMPING EQUIPMENT

60 YEARS

THERE IS NO ECONOMICAL SUBSTITUTE FOR QUALITY

AXELSON MANUFACTURING CO. • PLANTS — Los Angeles 58, California; St. Louis 16, Missouri. OFFICES — New York City 7, New York; Tulsa 1, Oklahoma; Buenos Aires, Argentina. DISTRIBUTORS — Jones & Laughlin Supply Co.; Great Northern Tool & Supply Co.; Industrial Agencies, Ltd., San Fernando, Trinidad, B. W. I.; Industrias Waldrip & Campbell, Barcelona, Caracas and Maracaibo, Venezuela; South American Supply Co., Ltd., Lima, Peru; Sociedad Comercial de Materias Primas Limitado, Rio de Janeiro, Brazil; G. Saavedra e Hijos, S. de R. L. Avenida Morelos 31, Mexico, D. F.; Dominion Oil Field Supply Co., Ltd., Calgary, Canada.

Announcement

MAGNESIUM ANODES

FORMERLY SOLD BY DOWELL INCORPORATED

now available from THE DOW CHEMICAL COMPANY

Effective January 1, 1952, The Dow Chemical Company reassumed the sale of magnesium anodes.

Years of research and testing have resulted in the present effectiveness of magnesium anodes as a proved method of corrosion control. Industry's recognition of the vital need for an economical means of protection, plus magnesium's advantageous qualities have steadily increased the use of magnesium for cathodic protection. In view of this rapid growth, the need for a closer coordination between research and development, production and sales was evident. In keeping with our policy of ever striving to serve industry better, Dow has reassumed the handling of Magnesium Anode sales.

CAST ANODES • GALVO-PAK® • GALVO-LINE® • GALVO-ROD

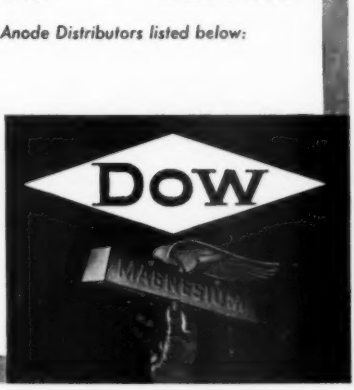
Contact the nearest Dow Sales Office or one of the Dow Magnesium Anode Distributors listed below:

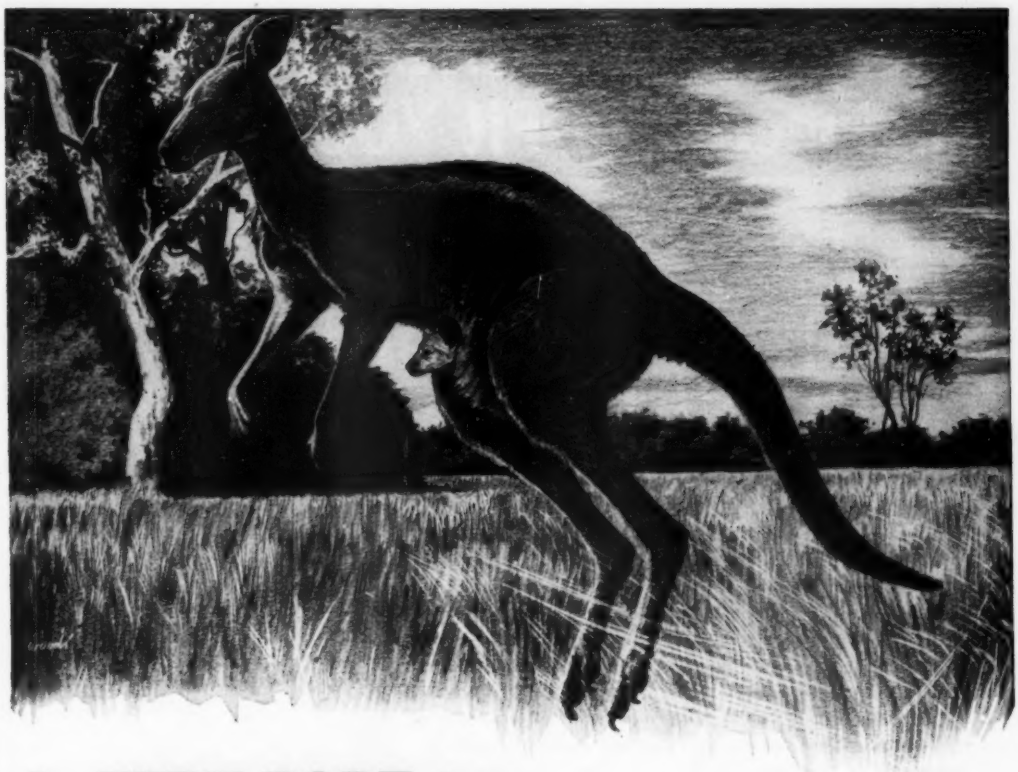
DOW SALES OFFICES: Atlanta • Boston • Chicago • Cleveland Detroit • Houston • Los Angeles • New York • Philadelphia San Francisco • Seattle • St. Louis

AUTHORIZED DISTRIBUTORS: ANTI-CORROSION MFG. CO., Atlanta, Georgia • CATHODIC PROTECTION SERVICE, Houston, Texas • DOWELL INCORPORATED, Tulsa, Oklahoma • ELECTRO-RUSTPROOFING CORP., Belleville, N. J. • STUART STEEL PROTECTION CORP., Plainfield, N. J. • THE VANODE CO., Pasadena, California

Magnesium Department

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN





in WIRE ROPE, too the RIGHT KIND of muscle makes the difference

Endowed with highly specialized leg muscles, the kangaroo is able to make tremendous flying leaps—even with Junior perched in the rumble seat.

In wire rope, too, specialized jobs call for specialized muscles. That's why in Wickwire Rope we make sure you always get the proper combination of physical properties to best resist the destructive forces found on your particular job—whether it be abrasion, load strain, shock stress or bending fatigue.

Wickwire Rope gives you the benefit of long experience and specialized know-how which assures you of exactly the right kind of rope your particular job demands.

For additional information write or phone our nearest sales office.

LOOK FOR THE YELLOW TRIANGLE ON THE REEL

THE COLORADO FUEL & IRON CORPORATION—Abilene (Tex.) • Denver • Houston • Odessa (Tex.) • Phoenix • Salt Lake City • Tulsa
THE CALIFORNIA WIRE CLOTH CORPORATION—Los Angeles • Oakland • Portland • San Francisco • Seattle • Spokane
WICKWIRE SPENCER STEEL DIVISION—Boston • Buffalo • Chattanooga • Chicago • Detroit • Emlenton (Pa.) • New York • Philadelphia

WICKWIRE ROPE

CF&I

PRODUCT OF WICKWIRE SPENCER STEEL DIVISION
THE COLORADO FUEL & IRON CORPORATION

There's a CONTINENTAL Model Engineered to Fit YOUR Job . . .

"RIGHT ON THE NOSE"

No matter what the specific requirements of your application, there's a Continental Red Seal model engineered and built to fill them, down to the very last detail—a model with exactly the right performance characteristics, profile, shape and weight . . . That is because Continental Motors produces some 80 basic models, to more than 2,000 different specifications, as set by the petroleum industry's varying requirements. When you buy a piece of equipment powered by Red Seal engine, you get the fine result of 50 years' aggressive engineering—50 years' experience in meeting industry's specialized needs . . . Choose a Continental Red Seal engine—gasoline or Cushioned Power Diesel—for the power, economy and long life that mean lowest running and upkeep costs.

INDUSTRIAL GASOLINE ENGINES

Model	Cyl.	Bore	Stroke	Displ.	Bare Engine H.P.
N56	4	2¼	3½	56	13.8 @ 2000 RPM
N62	4	2⅓	3½	62	15 @ 2200 RPM
Y69	4	2½	3½	69	21.4 @ 2400 RPM
Y91	4	2⅞	3½	91	28.5 @ 2400 RPM
Y112	4	3⅛	3½	112	32 @ 2400 RPM
F124	4	3	4½	124	36 @ 2400 RPM
F140	4	3⅛	4½	140	42 @ 2400 RPM
F162	4	3⅜	4½	162	49 @ 2400 RPM
F186	6	3	4½	186	60 @ 2400 RPM
F209	6	3⅛	4½	209	68 @ 2400 RPM
F226	6	3⅛	4½	226	73 @ 2400 RPM
M271	6	3⅜	4½	271	86 @ 2400 RPM
M290	6	3⅛	4½	290	92 @ 2400 RPM
M330	6	4	4½	330	104 @ 2400 RPM
B371	6	4⅛	4½	371	110 @ 2400 RPM
B427	6	4⅜	4⅞	427	127 @ 2400 RPM
G134	4	3½	4½	134	32.2 @ 2000 RPM
G157	4	3½	4½	157	37.7 @ 2000 RPM
H227	4	3⅝	5½	227	54 @ 2000 RPM
H243	4	3⅜	5½	243	58 @ 2000 RPM
H260	4	3⅞	5½	260	60.2 @ 2000 RPM
T371	6	4½	4½	371	119 @ 2400 RPM
T427	6	4⅜	4⅞	427	140 @ 2400 RPM
U501	6	4½	5½	501	160 @ 2400 RPM
R513	6	4½	5½	513	164 @ 2400 RPM
R572	6	4⅝	5½	572	182 @ 2400 RPM
R602	6	4⅞	5½	602	192 @ 2400 RPM
S749	6	5½	5½	749	217 @ 2200 RPM

INDUSTRIAL DIESEL ENGINES

Model	Cyl.	Bore	Stroke	Displ.	Bare Engine H.P.
GD157	4	3½	4½	157	37.5 @ 2000 RPM
HD243	4	3⅜	5½	243	53.1 @ 2000 RPM
HD260	*4	3⅞	5½	260	57 @ 2000 RPM
TD427	6	4⅜	4⅞	427	102 @ 2000 RPM
RD572	6	4⅝	5½	572	137 @ 2000 RPM

*Available for Industrial applications only.

6218 CEDAR SPRINGS ROAD, DALLAS 9, TEXAS . . . 3817 S. SANTA FE AVE., LOS ANGELES 58, CALIF.

CONTINENTAL MOTORS — Powerful as the Nation — AMERICA'S STANDARD — OUR 50th YEAR 1902 1952

Continental Motors Corporation
MUSKEGON, MICHIGAN

. . . . . PARTS AND SERVICE EVERYWHERE . . . . .

4" and 8" A.C.F. Lubricated Plug Valves handling premium and regular-grade gasoline at Shell Oil Company's Wilmington, N. C., Marine Terminal.

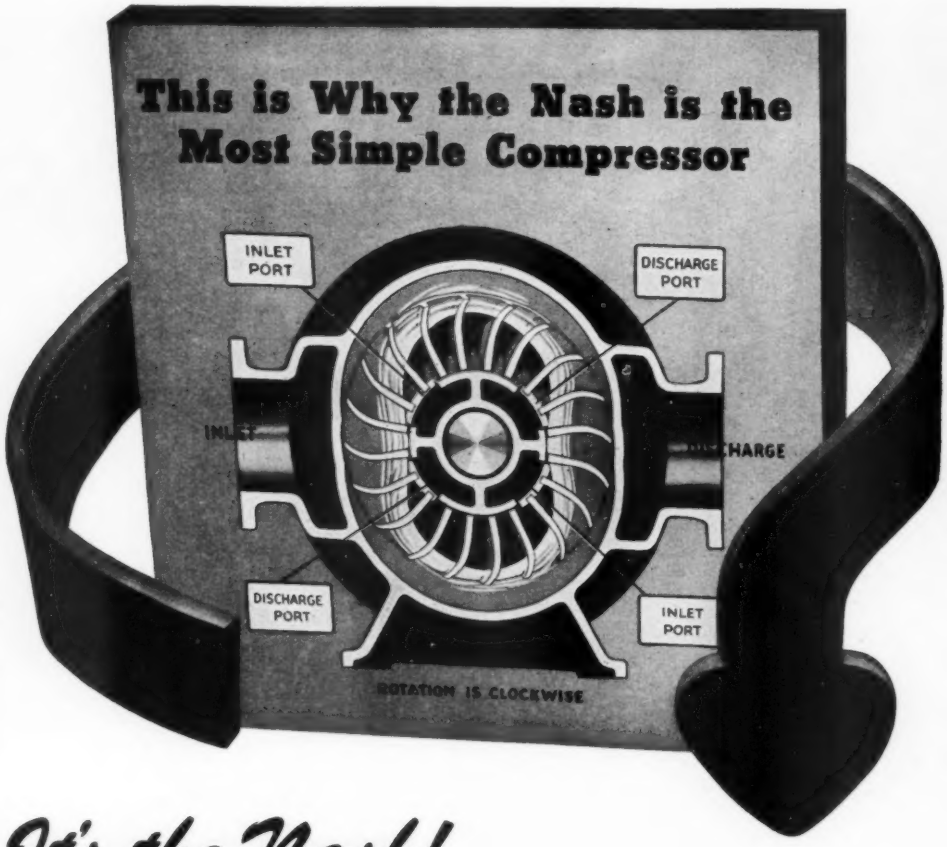
NO 'BRAKES' ON FLOW

Filling or emptying... small storage tank or huge tanker... lading flows faster through A.C.F. CYLINDRICAL Lubricated Plug Valves. The passage through the valve does not slow the flow, since it has at least as much area as the pipe. There is no 'throttling' effect with A.C.F. Valves!

A.C.F. CYLINDRICAL FULL PIPE AREA **PLUG VALVES**

Representatives in 50 Principal Cities

Ask for Catalog 4-OG, American Car and Foundry Company, Valve Division, 1501 East Ferry Avenue, Detroit 11, Michigan



It's the Nash!

There are no mechanical complications in a Nash Compressor. A single moving element, a round rotor, with shrouded blades, forming a series of buckets, revolves freely in an elliptical casing containing any low viscosity liquid. This liquid, carried with the rotor, follows the elliptical contour of the casing.

The moving liquid therefore recedes from the rotor buckets at the wide part of the ellipse, permitting the buckets to fill with gas from the stationary Inlet Ports. As the casing narrows, the liquid is forced back into the rotor buckets, compressing the gas, and delivering it through the fixed Outlet Ports.

Nash Compressors produce 75 lbs. pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure. Since compression is secured by an entirely different principle, gas pumping problems difficult with ordinary pumps are often handled easily in a Nash.

Nash simplicity means low maintenance cost, with original pump performance constant over long periods. Data on these pumps sent immediately on request

No internal wearing parts.

No valves, pistons, or vanes.

No internal lubrication.

Low maintenance cost.

Saves floor space.

Desired delivery temperature automatically maintained.

Slugs of liquid entering pump will do no harm.

75 pounds in a single stage.

NASH ENGINEERING COMPANY
313 WILSON, SO. NORWALK, CONN.

TWO DEPENDABLE, CONSISTENT MATERIALS...

Tops in the field

...for lightening cement slurries

...for restoring lost circulation

with excellent bridging effectiveness...

Strata-Crete* the lightweight, processed perlite aggregate not only permits higher columns at lower pressures ... but also bars loss of cement slurry ... greatly reduces perforation cracking or shattering.

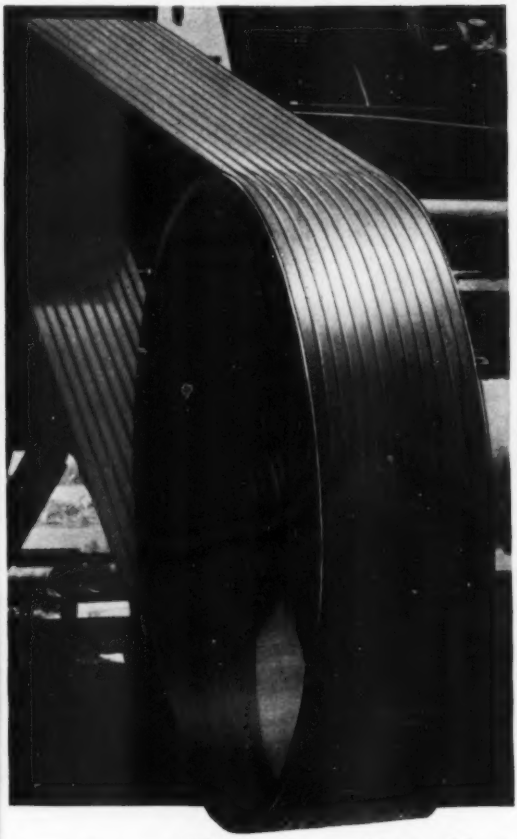
with excellent bridging qualities...

Strata-Seal* has *proved* its superiorities in well after well ... chemically inert, is not affected by mud or heat ... permits screening ... cuts rig downtime ... often saves abandonment.

*Trade Mark GLCC

STRATA-CRETE SALES
GREAT LAKES CARBON CORPORATION
5845 Atlantic Ave., Long Beach 5, Calif.
Offices in Principal Oil Centers
In the States of Texas, Louisiana, Oklahoma, Kansas and New Mexico Strata-Crete and Strata-Seal are available only through Great Lakes Corporation, Long Beach 5, Calif.

Packed in 4 cu. ft. bags. Available through Leading Oil Well Cementing Concerns; Leading Mud Service Companies. Write for more data.



How to get Teamwork out of V-Belts

(1) Match them for length*

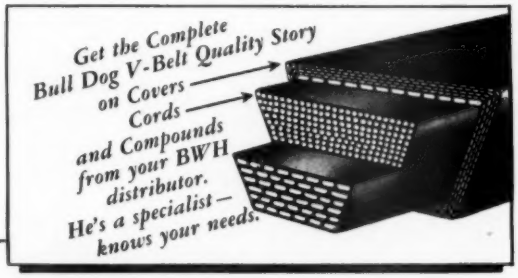
(2) Match them in make*

(3) Check sheaves for alignment and groove wear

(4) Install Sets of Bull Dog V-Belts for Uniformity of Quality...

**Should* an individual belt fail, it is neither practical nor economical to replace it with a new belt. The new belt may be either shorter or longer than the remaining belts. If shorter, the excessive overload it must carry will cause early failure. If longer, it will not carry its share of the load, thus adding nothing to the life of the drive.

You can't be sure about length or compare hours worked unless you install new V-Belts by the set. You can't be sure of uniformity of quality unless you install Bull Dogs.



BWH
DEPENDABLE RUGGEDNESS

Another Quality Product of

BOSTON WOVEN HOSE & RUBBER COMPANY

Warehouse Stock: 111 N. Canal St., Chicago, Illinois **Distributors in all Principal Cities**

PLANT: CAMBRIDGE, MASS. • P. O. BOX 1071, BOSTON 3, MASS., U. S. A.

What is 100% Safe?

Anything less than 100% safe is 100% UNsafe.

This fellow's lucky, in a way. He *thought* his safety valves were 100% safe, and because they weren't, they might have killed him. Because those valves were *almost* safe, it's going to cost someone a lot of money.

There's only one way to think of safety—think in terms of 100% or nothing. There's one sure way to *get* 100% safety—specify BalanSeal or FarriSeal Valves.

Why? Because they *can't* stick, plug or corrode. Critical working parts are permanently isolated from any contact whatever with the lading.

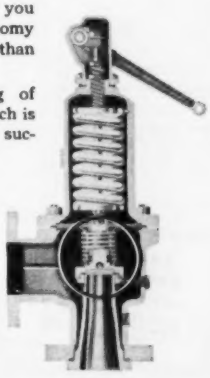
Because they're unaffected by back pressures in the discharge manifold due to its own operation or to the opening of other valves in the line.

Because these features make it possible for you to use smaller discharge piping, an economy which often amounts to substantially more than the cost of the valves.

You'll be interested in the engineering of BalanSeal and FarriSeal Valves—design which is rapidly gaining acceptance in hundreds of successful installations.

Ask for our "8-Minute Brief."

Your Safety's REAL With FarriSeal

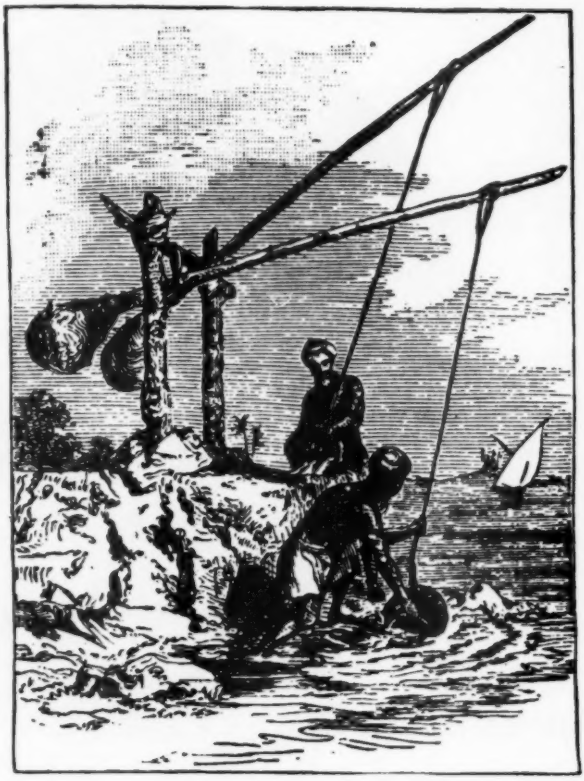


Farris ENGINEERING CORP.

412 COMMERCIAL AVE., PALISADES PARK, N.J.

1191

The Pump that wasn't a pump



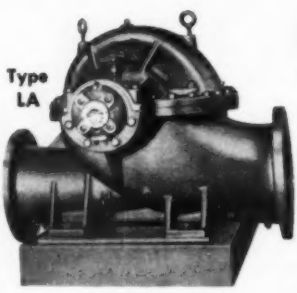
For many years this peculiar looking contrivance was the most efficient means known for moving water from one level to another—but it wasn't really a pump, it was a "shadoof".

Though still used today in many parts of the world, this hand-operated "bailing lever" is said to have been used 3000 years ago by the ancient Babylonians. On the basis of six strokes a minute, with a bucket that held 60 pounds of water, it could raise 36 gallons per minute. Those "bags" on the short end are used as counterpoises to lift the filled vessels.

If this were 3000 BC and you were looking for a pump for *any* purpose, the best Worthington could do for you would be to recommend a shadoof. The drive? Only *one* available—a husky slave.

Almost fantastic, isn't it, that crude devices like the shadoof, the mechanical innovations of their day, were the starting points for modern Worthington pumps—centrifugal pumps that can move as much as 250,000 gallons per minute; individual designs with 100,000 standard combinations of capacities, heads, casings, and mountings for *any* drive available; single-stage, multi-stage, volute, turbine, horizontal, vertical, Mixflo, Axiflo and regenerative pumps—for virtually every need of utilities, petroleum, paper, sugar, food, chemical, marine, water works, metal-working, and many other industries.

Yes, there's a Worthington pump for your requirement—a pump that's *standard* with Worthington. To find out about it, consult your nearest Worthington District Office or write to Worthington Pump and Machinery Corp., Centrifugal Pump Div., Harrison, N. J.

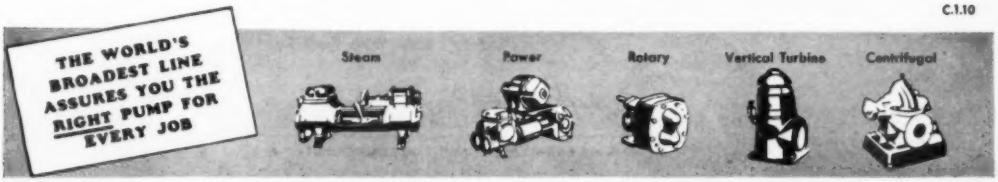


When you buy Worthington centrifugal pumps—the most complete line you'll ever find—you'll always be assured of the *right* pump for every job. Typical of this broad Worthington line is this large LA (to 60,000 gpm) at left; monobloc DN pump (to 2500 gpm), center; and the CN, frame-mounted version of the DN, in over 10,000 combinations.

WORTHINGTON

C.1.10

THE WORLD'S BROADEST LINE ASSURES YOU THE RIGHT PUMP FOR EVERY JOB

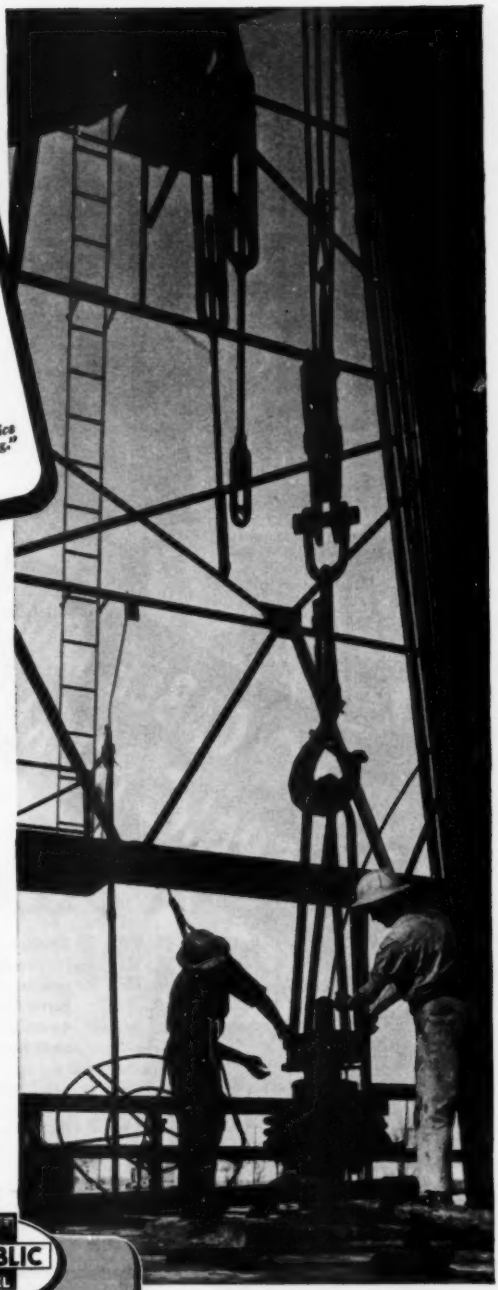


REMINDERS OF GOOD CASING PRACTICES:

How to save strings from slip-cutting

Slip elevators are recommended for long strings. Both spiders and elevator slips should be clean and sharp and should fit properly. Slips should be extra long for heavy casing strings. Spider and elevator slips should be examined and watched to see that all lower together. If they lower unevenly, there is danger of denting the pipe or badly slip-cutting it.

Reprinted by permission from "API Recommended Practice RP5C1: Care and Use of Casing, Drill Pipe and Tubing."



...another reminder

REPUBLIC Electric Weld Casing and Tubing

- ***Resist collapse***—They're uniformly round, uniformly strong, and uniform in wall thickness. Each length is cold formed from high ductility steel, fully normalized for uniform structure. Casing is cold sized to further increase its high yield strength.

- ***Resist pull-out***—Uniform wall thickness and roundness mean that a uniform depth of tough steel is left under thread roots all around the pipe . . . no pull-out inviting thin spots.

- ***Make-up fast***—Uniformly straight lengths speed stabbing. Clean, full-formed threads spin-in and tong-up fast.

REPUBLIC STEEL CORPORATION
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N.Y.

REPUBLIC *Electric Weld* **NORMALIZED CASING AND TUBING**

REPUBLIC STEEL

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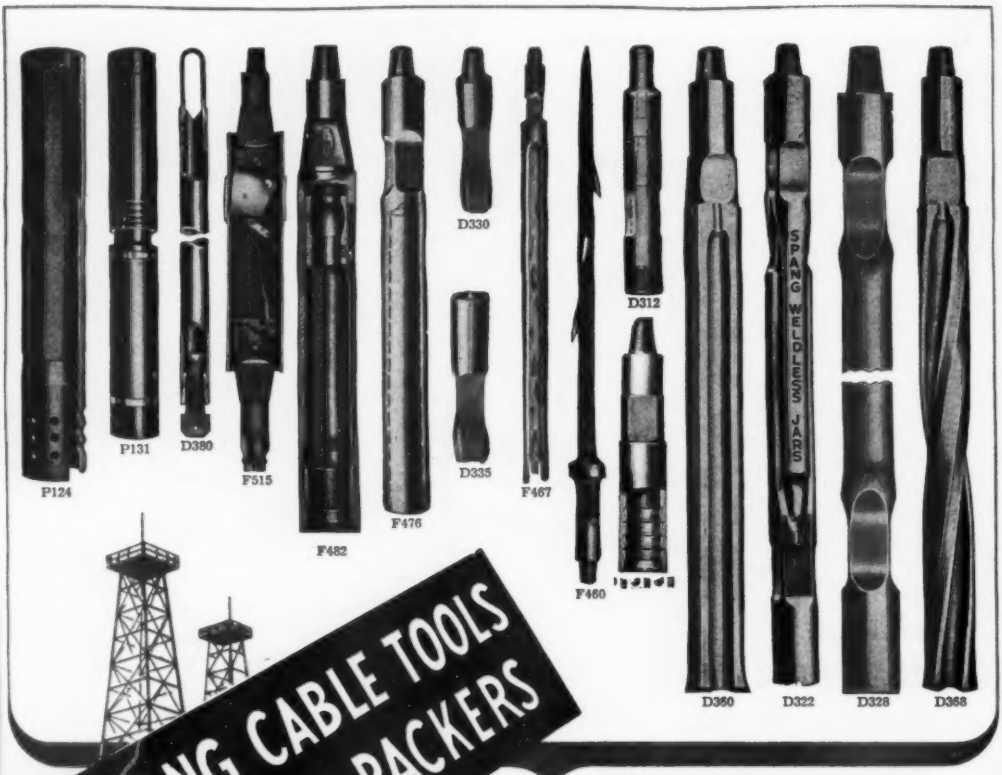

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Spang Cable Tools and Spang Packers have been developed in the belief that the best equipment and the best maintenance result in the most economical drilling. Spang Tools, built for rugged service, are known and preferred the world over. They are available through leading supply companies and field shops everywhere.

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The Higher Standard

They Say—

Little Growth Under Controls

"There is no current shortage but the urgent need for a greatly expanded program of petroleum exploration and development to meet defense and future needs is apparent.

"Under price controls the expansion is lagging, and this at a time when the Petroleum Administration for Defense, the military and national security council are urging more activities. A drilling program of 50,000 wells in 1952 and 53,000 wells in 1953 has been proposed, representing increases of 13 and 23 per cent over 1951. It is quite unlikely that such goals can be reached under the price control program."

Editorial in the El Dorado Daily News, El Dorado, Ark.

Monotonous Forecast

"Probably more nonsense has been prophesied about oil than any other basic resource. Somebody always is coming up with the woeful warning that we are going to run out at any moment."

Editorial in the Oil City Derrick.

Strikes Hinge on Defense

"Striking at the heart of the oil industry is the union policy threat. A strike is ostensibly aimed at a corporation or individual owners, but actually it extends to the federal Government and thence to all the people.

"There is a fairly general opinion that the big unions are on their last go-round. There have been several rounds of wage increases; that has brought us up against inflation; every such 'gain' for labor is an inflationary process.

"Whenever the federal Government halts its tremendous spending there will be a quick drop in many lines; there will be an automatic cessation of strikes. This proposed oil strike and the steel and other strikes held in abeyance are all based on the terrific flow of federal money and defense contracts. Somewhere along the line, rather soon, there will be a break in the vicious circle."

Editorial in the Tulsa World.

Disappearing Profits

"The over-all level of taxation in times of emergency spending by our Government should properly reach the limit that a free enterprise can stand.

"But how the over-all tax burden is divided has a great deal to do with the things we are arming to preserve. Taxes that are so graduated, first on the corporate income and then once

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Pear-shaped ring permits greater adaptability in pulling poles, stumps, beams, etc.
In claw lifting, the ball and socket design of the head and claw assures greatest support area and protects against the load shifting.
1523

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No. 1523 All-purpose OIL FIELD JACK

This is the ultimate in versatility for oil field jacking service. With its swivel base permitting full 15-ton capacity at any angle, the No. 1523 Jack was designed for four types of service: (1) *straight lifting* with the load applied to the head . . . (2) *chain lifting* . . . (3) *claw lifting* . . . and (4) *foot lifting* of low height loads with the integral foot lift. Ruggedly built for long service, this dependable jack is safe and easy to operate under all conditions.

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TYPE "R"

TYPE "S"

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TYPE "B" RELEASING ATTACHMENT

GUIBERSON *Wire Line Oil Savers*

for Excellent Pack-Off—Clean, Dry Line

3 to choose from—take your choice and know that if it's Guiberson, it's *good!*

TYPE "R"—for tubing. Simple, inexpensive, effective. Split housing for easy installation.

TYPE "S"—for casing or tubing. Economical, simple—similar to "R" but heavier construction, flange bottom or tubing connection.

TYPE "D"—for tubing or casing. Two independent sets of rubbers, single end operation, make it cost more but still very economical. Pin or flange adapter connection.

Non-sparking brass bushings and guides throughout . . . long-wearing rubbers . . . finest Guiberson precision construction.

TYPE "B" RELEASING ATTACHMENT—Positive release for Oil Savers—prevents tool damage, necessity for flagging line. Easy to attach, pressure won't release it.

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again on the same income when it is received by the stockholder, as to leave practically nothing as return on investment and as compensation for risks get us very close to a profitless economy."

Floyd B. Odlum, president of Atlas Corp., in the company's annual report.

Advice to Oil Men

"Be so vitally interested and sold on your own products that you have no time or inclination to damn your competitor. Then, two things will grow out of this: (1) You will enjoy life personally, because you will be living in a positive, constructive manner, and (2) you will place the great industry, of which you are an important cog—whether you be humble or great—in a position to maintain a united front, so that greater achievements will be ahead in the years to come than those which have so miraculously been accomplished in the past."

H. Roe Bartle, regional economic stabilizer, Kansas City, addressing the annual convention of the Iowa Independent Oil Jobbers' Association, Des Moines.

CALENDAR

March

Texas Independent Producers and Royalty Owners Association, sixth annual meeting, Fort Worth, March 27-28.

North Texas Oil and Gas Association, twenty-second annual meeting, Kemp Hotel, Wichita Falls, Tex., March 29.

Western Petroleum Refiners Association, annual meeting, Plaza Hotel, San Antonio, March 31-April 2.

Mid-West Gas Association, annual meeting, Hotel Radisson, Minneapolis, Minn., March 31-April 2.

American Chemical Society, division of petroleum chemistry, annual meeting, Milwaukee, March 31-April 3.

April

Oil and Gas Conservation Institute, University of Oklahoma, Norman, Okla., April 2-3.

Pacific Coast Gas Association, annual transmission conference, Berkeley, Calif., April 2-3.

American Petroleum Institute, Division of Production, eastern district, Hotel William Penn, Pittsburgh, April 3-4.

Florida-Georgia Gas Association, annual convention, Soreno Hotel, Saint Petersburg, April 3-5.

Missouri Liquefied Petroleum Gas Association, Hotel President, Kansas City, Mo., April 7-9.

American Society of Lubrication Engineers, annual meeting, Statler Hotel, Cleveland, April 7-9.

Arizona Geological Society of America, forty-eighth annual meeting, University of Arizona campus, Tucson, Ariz., April 11-12.

Petroleum Industry Electrical Association and Petroleum Electrical Supply Association, twenty-fourth annual joint conference, Mayo Hotel, Tulsa, April 14-17.

American Institute of Electrical Engineers, District 7 meeting, Hotel Jefferson St. Louis, April 15-17.

Association of American State Geologists, annual meeting, Tallahassee, Fla., April 15-19.

National Petroleum Association, semian-

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• accurate
• durable
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A tape made for oil rigging and derrick work, the Lufkin Chrome-Clad Derrick Tape has a specially designed hook for easy measurement of upright pipe and casing. Can also be used for general measuring. The Chrome-Clad line is easier to read because the jet-black markings stand out sharp and clear against the chrome-white background. Tape is mounted in a well-designed, sturdy frame. Rugged and durable, the Lufkin Derrick is a tape that can "take it." Available in 100, 150 and 200 ft. lengths. Graduated feet, 10ths and 100ths of feet.

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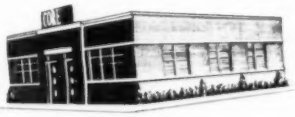
ON-LOCATION CORE ANALYSIS

STATION WAGON CORE ANALYSIS

SUITCASE CORE ANALYSIS

FROZEN CORES

SIDE WALL CORE ANALYSIS



OFF-LOCATION CORE ANALYSIS

WELL LOGGING (on-shore)

WELL LOGGING (off-shore)

WELL SAMPLING

RESERVOIR FLUID ANALYSIS

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CORE LAB

PETROLEUM RESERVOIR ENGINEERING

nual meeting, Hotel Cleveland, Cleveland April 16-18.

American Petroleum Institute, Division o Transportation, pipe-line conference, Black stone Hotel, Fort Worth, April 21-23.

American Petroleum Institute, safety and fire-protection committees, Hotel Texas Fort Worth, April 21-24.

National Petroleum Council, conference rooms A and B of the Interior Department Auditorium, Washington, D. C., April 22.

American Petroleum Institute, Division o Production, Rocky Mountain district, Glad stone Hotel, Casper, Wyo., April 24-25.

Indiana Gas Association, annual meeting French Lick Springs Hotel, French Lick Ind., April 24-25.

Ardmore Geological Society, field trip, East of Ardmore and South of the Arbuckle Mountains, April 25-26.

Independent Petroleum Association o America, midyear meeting, Deshler-Wallick Hotel, Columbus, Ohio, April 28-29.

Southern Gas Association, annual conven tion, Galveston, Tex., April 28-30.

American Oil Chemists' Society, spring meeting, Shamrock Hotel, Houston, April 28-30.

Southern Gas Association, annual convention, Galveston, Tex., April 28-30.

American Institute of Electrical Engineers, District 1 meeting, Binghampton N. Y., April 30-May 2.

Natural Gasoline Association of America annual meeting, Rice Hotel, Houston, April 30-May 2.

May

Southeastern Section Geological Society of America, and Southeastern Mineral Symposium, joint meeting, Hotel Roanoke Roanoke, Va., May 1-3.

National Air Pollution Symposium, Huntington Hotel, Pasadena, Calif., May 5-6.

American Geophysical Union, thirty-third annual meeting, National Academy o Sciences, National Research Council, Washington, D. C., May 5-7.

Interstate Oil Compact Commission, spring meeting, Phoenix, Ariz., May 8-9

Texas Petroleum Research Committee, Fourth Oil Recovery Conference, Austin, Tex., May 8-9.

American Institute of Chemical Engineers regional meeting, French Lick, Ind., May 11-14.

American Association of Petroleum Geologists, regional meeting, Mayo Hotel, Tulsa May 12-13.

American Gas Association, Natural Gas Department, spring meeting, Biltmore Hotel Los Angeles, May 12-13.

Annual Liquefied Petroleum Gas Association convention and trade show, Palmer House, Chicago, May 12-14.

American Petroleum Institute, Division o Refining, seventeenth midyear meeting, San Francisco, May 12-15.

Pennsylvania Gas Association, Wernersville, Pa., May 13-15.

Intermountain Association of Petroleum Geologists, Third Annual Field Conference, the Basin and Range Province from Cedar City, Utah, to Las Vegas, Nev., May 13-16.

American Petroleum Institute, Division o Production, Pacific Coast district, Biltmore Hotel, Los Angeles, May 15-16.

American Petroleum Institute, division of marketing, midyear meeting, Copley Plaza Boston, May 19-20.

Gas Appliance Manufacturers Association annual meeting, Broadmoor Hotel, Colorado Springs, Colo., May 21-23.

American Gas Association, production and chemical conference, Hotel New Yorker New York, May 26-28.

Southwestern Gas Measurement Short Course, University of Oklahoma, Norman May 27-29.

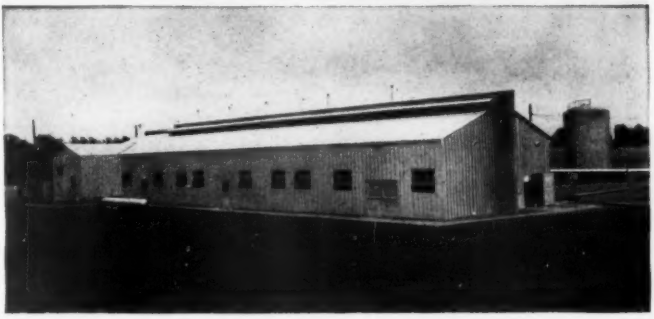
Society of Exploration Geophysicists Gulf Coast regional meeting, Rice Hotel Houston, May 29-30.

Seventh annual short course in gas technology, sponsored by the Southern Gas Association, Texas College of Arts and Industries, Kingsville, Tex., May 28-30.

June

Society of Automotive Engineers, summer

Why Oil Men Specify Butler Buildings



Butler Building, specially adapted as compressor station for gas pipe line transmission company at Lebanon, Ohio, has brick firewall through center of building.

Straight sidewalls, trussclear construction give maximum space for stacking in oil company warehouse at Oklahoma City, Okla.

Butler Buildings can be used for various pumping operations. This pumping engine house is one of 18 used by oil company at Lorraine, Kans.

In production, refining, marketing, Butler Aluminum*-Covered Buildings offer these advantages:

(1) High reflectivity for insulation.

(2) Lightweight, yet sturdy and durable for longer life with less maintenance.

(3) Easily erected.

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(6) Weathertight.

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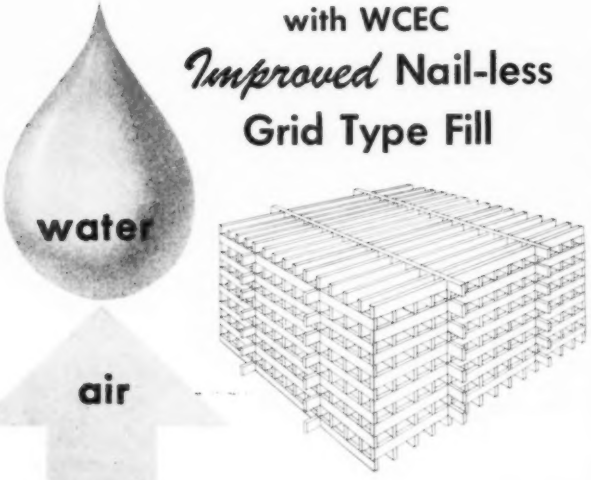
most wetted surface . . .

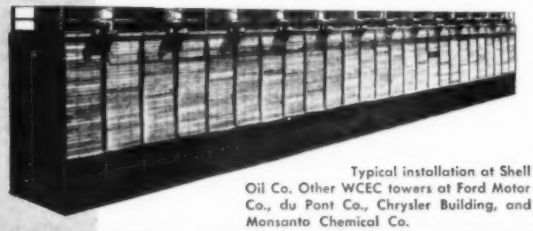
with WCEC *Improved* Nail-less Grid Type Fill



WCEC new improved grid type fill provides more wetted surface and greater retardation of descending water than any other design. The water is repeatedly interrupted and refilmed in its downward passage. The rising air is guided through open lanes in intimate contraflow with the water. This maximum wetted surface and maximum retardation of the water completely utilizes the heat removing capacity of the air with minimum possible air resistance, resulting in highest cooling efficiency. Consider this important feature when you consider the purchase of a cooling tower.

SEE OUR CATALOG IN SWEETS FILE

TOWERS OF STRENGTH WCEC



Typical installation at Shell Oil Co. Other WCEC towers at Ford Motor Co., du Pont Co., Chrysler Building, and Monsanto Chemical Co.

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REPRESENTATIVES IN TWENTY-EIGHT PRINCIPAL CITIES

meeting, Ambassador and Ritz-Carlton Hotels, Atlantic City, N. J., June 1-6.

Pennsylvania Grade Crude Oil Association, annual meeting, Hotel William Penn, Pittsburgh, June 5-8.

Canadian Gas Association, Chateau Frontenac, Quebec, June 8-12.

American Petroleum Institute, midyear standardization meeting, Brown Palace Hotel, Denver, June 9-14.

Western Petroleum Refiners Association, regional technical and industrial-relations meeting, Broadview Hotel, Wichita, Kans., June 12-13.

International Gas Conference, Brussels, Belgium, June 16-22.

Kentucky Oil and Gas Association, annual meeting, Hotel Lafayette and Phoenix Hotel, Lexington, Ky., June 19-20.

Petroleum Equipment Suppliers Association, Mark Hopkins Hotel, San Francisco, June 23-25.

Michigan Gas Association, annual meeting, Grand Hotel, Mackinac Island, Mich., June 23-24.

American Society for Testing Materials, annual meeting, Hotel Statler, New York, June 23-27.

American Institute of Electrical Engineers, summer general meeting, Nicollet Hotel, Minneapolis, Minn., June 23-27.

August

Wyoming Geological Association, field trip, Big Horn Basin, August 1-3.

Society of Automotive Engineers, national West Coast meeting, Fairmont Hotel, San Francisco, August 11-13.

American Institute of Electrical Engineers, Pacific general meeting, Westward Ho Hotel, Phoenix, Ariz., August 19-22.

September

Pacific Coast Gas Association, Ambassador Hotel, Los Angeles, September 3-5.

Instrument Society of America, seventh national instrument conference and exhibit, Cleveland, September 8-12.

National Petroleum Association, fiftieth annual meeting, Hotel Traymore, Atlantic City, N. J., September 10-12.

American Institute of Chemical Engineers, regional meeting, Palmer House, Chicago, September 11-13.

Western Petroleum Refiners Association, regional meeting, Hotel Henning, Casper, Wyo., September 25-26.

American Association of Oilwell Drilling Contractors, annual meeting, Skirvin Hotel, Oklahoma City, September 28-30.

October

Independent Natural Gas Association of America, annual meeting, Fontenelle Hotel, Omaha, Neb., October 6.

California Natural Gasoline Association, twenty-seventh annual fall meeting, Ambassador Hotel, Los Angeles, October 9-10.

Society of Exploration Geophysicists, midwestern meeting, Texas Hotel, Fort Worth, November 13-14.

Texas Mid-Continent Oil and Gas Association, thirty-third annual meeting, Hotel Texas, Fort Worth, October 13-15.

American Institute of Electrical Engineers, fall meeting, New Orleans, October 13-17.

Natural Gasoline Association of America, southern regional meeting, Blackstone Hotel, Tyler, Tex., October 19.

Independent Petroleum Association of America, annual meeting, Mayo Hotel, Tulsa, October 20-21.

NOMADS

Tulsa Nomads, third Friday of each month. After Five Room, Tulsa Hotel.

Dallas-Fort Worth Nomads, first Monday of each month, Greater Dallas Club.

Houston Nomads, second Monday of each month, Ye Ole College Inn, Houston.

Los Angeles Nomads, second Wednesday of each month, Jonathan Club.

Here-at last!

Here at last is a non-fluorescing emulsion mud the geologist has been waiting for—OB No-Glo. Now, when cores and samples show evidences of fluorescence, or a stained cut with petroleum ether, or carbon tetrachloride, you can be absolutely sure *it is not caused by the mud.*

OB No-Glo is a ready-mixed emulsion mud concentrate containing the oil as well as the emulsifier. It provides all of the desirable characteristics of a good oil emulsion mud—low fluid loss, excellent viscosity, gel strength, plastering properties and lubricating qualities—that speed up the rate of drilling and help prevent mechanical difficulties. One drum (407 lbs. net) is added to every 5 bbls. clay-water mud in the system, thereby making a sodium base emulsion of about 14% oil and 10 lbs. emulsifier to the barrel. It can be chemically treated in the normal manner and is easily converted to a lime-base, non-fluorescing emulsion by adding 2 lbs. hydrated lime and 1 lb. caustic soda to each barrel of the emulsion. OB No-Glo can be used with salt water muds as well as ordinary clay or bentonite-water hole muds. It will not foam or ferment—is not a soap—and contaminants such as cement, anhydrite, etc. have little effect on No-Glo lime-base emulsion. OB No-Glo is the result of intensive research for this type of a mud, and is the only non-fluorescing, non-cutting, odorless emulsion available today. For complete details write—

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Most thread dopes in use today will eventually contaminate OB No-Glo emulsion mud and cause it to fluoresce. That is why it is mandatory to change to OB No-Glo Thread Lubricant (a non-fluorescing compound) when using OB No-Glo in your drilling mud. Packed in 100 lb. carboys, and 50 lb. and 25 lb. pails.

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Econo Magic	Pepto Magic
Voodoo Dust	Magic Milk
OB Well Wash	Test Equipment
OB Mud Guns	Hand Cleaner
OB No-Glo	OB Formaseal

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THE OIL AND GAS
JOURNAL
TULSA, OKLAHOMA

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JOURNALLY Speaking

Earthy Humor

ANY sort of physicist is popularly supposed to be a long-haired, wild-eyed, utterly humorless individual, so by the same token a geophysicist should be even more so. But Colin C. Campbell, manager of the Society of Exploration Geophysicists, must have had his tongue in his cheek and a twinkle in his eye when he wrote us:

"The object of this society is to promote the science of geophysics, especially as applied to the search for petroleum and other minerals. But, try as we may to establish exploration geophysics as an honorable profession, our efforts are thwarted by anonymous members of our group like the one who authored the following diatribe:

"'A GEOPHYSICIST is a person who passes as an exacting expert on the basis of being able to turn out with prolific fortitude infinite strings of incomprehensible formulae calculated with micromatic precision from vague assumptions which are based on debatable figures taken from inconclusive experiments carried out with instruments of problematic accuracy by persons of doubtful reliability and questionable mentality for the avowed purpose of annoying and confounding a hopeless chimerical group of fanatics known as geologists.'"

At least we hope the above is a joke; we wouldn't want to antagonize all geologists if they really are a "chimerical group of fanatics." However, the geophysicists and the geologists must get along together pretty well, for they are having their annual meetings jointly in Los Angeles this week.

To mark that occasion our favorite oil publication is running in this issue a very special section which includes a long dissertation on geophysics. And to show that geophysicists don't always deal in "infinite strings of incomprehensible formulae," this series of articles can be understood by people who know no higher mathematics beyond trigonometry.

We were about to say that we are glad to note that geophysics can thus be brought down to earth, but that would be mixing metaphors in view of the root definition of that word; better say we're glad geophysics is coming up out of the depths. After all, a man who is an earth scientist ought to be made of common clay like the rest of us.

On the Other Hand

OOOPS—we renege on that thought that earth scientists may be common clay. We just saw an advance proof of T. H. Philpott's presidential address to the paleontologists. Take a look at pages 164 to 167, and judge for yourself.

Maybe you don't need to know trig or even long division to understand it, but you need something less commonplace than Webster's unabridged dictionary. Even the title, "Paleofacies," isn't in the dictionary, and neither are some of the other jawbreakers that Earthman Philpott tosses around so glibly, such as miomacropaleontology, cyrtopaleontologist, stenohaline, and cyclammamina caneriverensis. Well, it takes all kinds to make a world, they say, and that goes double for the world of petroleum. Anyway, we always said petroleum is a progressive industry, and here's a case where it has progressed way ahead of Mr. Webster.

You'll Like This

BUT here's something you all can appreciate even if you don't know a thing about higher math or pliomicropaleontology. At least you can look at the pictures.

We're talking about the big, multicolored map that's folded into this issue. If you have this displayed near your desk you can impress your friends with your knowledge of geology and where and how oil is found. It shows the basins where oil has been—and will be—discovered in this country and gives cross-sectional views of what's down underneath them.

That big rainbow-looking thing at the bottom, incidentally, was published by the Journal a couple of years ago and proved so popular that we had to reprint it twice (at 50 cents per copy) to supply the demand. Now all you subscribers get another edition of it, with all this basin stuff to boot, at no extra charge. That's getting information on the earth cheap as dirt.

—*Henry D. Ralph.*

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JOURNAL
Vol. 50, No. 46

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Brings "LASTING" Results

Science can find oil, but something more is needed

THIS week in Los Angeles several hundred technologists who apply the various earth sciences to the problem of finding oil are discussing a group of papers so technical that the average oil man can get little or nothing out of them. Yet each of the papers may, in one way or another, lead to the discovery of another oil field.

This illustrates the growing complexity of the petroleum industry and the extent to which science is directing its course. It is paying off handsomely. During the last 5 years wildcat wells drilled more or less at random and without the benefit of scientific aids had a success ratio of only 1 in 30, while wildcats located on the basis of scientific studies had a success ratio of 1 in 5. This is a saving to the industry of 25 dry holes out of 30 exploratory wells seeking new pools.

The day is well past—though still fresh in the memory of oil men not yet gray—when geologists, engineers, and other technically educated men were scorned by the oil industry and had to fight to prove their value.

BEFORE technology arrived, the oil industry depended entirely on its own fortitude, on trial and error, on luck, pluck, and initiative—in short, on individual enterprise. And it should never be forgotten that individual enterprise served the industry and the nation well while it was on its own and before technology came to help.

The impressive achievements of science in exploration, in refining, and in all other branches of the industry should not blind us to this fundamental fact: Science can locate oil and perform other wonders when properly applied, but by itself it is lifeless. Technology must be put to work by the addition of an indispensable ingredient—the vital force of individual initiative and economic incentives to take a risk.

Science alone won't get the oil out of the earth and turn it into a myriad of useful products; science alone won't provide the drive, the capital, nor the managerial skills to extract a natural resource and convert it to human needs. Science is not industry, and only industry achieves production.

WITHOUT technology, industry gropes blindly; but without industry, science is ineffectual. The two must work hand in hand, a partnership, each recognizing the essential contributions of the other.

No one now must tell the oil industry that it needs continually improving technology. But many people need to be told over and over again that what makes the industry and what is the only assurance of oil for the future is the driving force of individual enterprise and incentive.

THIS WEEK

IN SEARCH OF OIL.—Geophysics and the other sciences used in finding oil are being reviewed and advanced at meetings of three technical societies in Los Angeles this week. This week also the Journal presents its annual exploration number, with special articles beginning on page 105.

FINDING OIL—Scientific techniques of oil exploration will get a thorough discussion at the joint meeting of A.A.P.G., S.E.G., and S.E.P.M. this week in Los Angeles. . . . And there is still plenty of oil to be found, according to NPC. . . . There's enough to last this country for many years to come. . . . The more oil used, the more oil will be found. . . . ¶But an increased rate of drilling, plus a high rate of geological and geophysical activity are necessary in the immediate future, according to Ohio Oil Co.'s president. . . .

REFINING—Sunray has started construction of a new 28,000-bbl. refinery near Corpus Christi. . . . Completion is scheduled in the summer of 1953. . . . ¶Socony-Vacuum will spend $35,000,000 this year on further refinery expansion here and in Europe. . . . $27,000,000 of this will be spent for three T.C.R. units at Augusta, Kans.; Beaumont, Tex.; and Torrance, Calif. . . .

NATURAL GAS—A court test of Texas' natural-gas-gathering tax has been postponed until April 7. . . . Two of the 49 cases pending, those of Panhandle Eastern and Michigan-Wisconsin Pipe Line, will be tried in 112th District Court at Austin. . . . ¶The OPS is being urged by Rep. Wright Patman of Texas to move a scheduled hearing to Marshall, Tex., on a protest suit against the ceiling price set for gas from Woodlawn field, Texas. . . .

INDUSTRY—The WSB is expected to take up a study of the petroleum labor situation this week. . . . O.W.I.U. president assures board that operations will continue normally while study is under way. . . . ¶The International Petroleum Exposition will be held in Tulsa May 14-23, 1953, committee decides. . . . ¶Engineers in the petroleum industry who aspire to become managers must possess many other skills in addition to engineering ability, Petroleum Engineering-Management Conference agrees. . . .

PIPE LINES—If Gulf Interstate's 1,000-mile, 30-in. transmission line ever becomes a reality, it will be unique in that it will be the first large transmission carrier to handle natural gas entirely on a fee basis. . . . The newly formed company plans to build the line from the Gulf Coast to northeastern Kentucky expressly for the purpose of hauling gas for United Fuel Gas Co. . . . ¶Pacific Northwest Pipeline Corp.'s plan to "swap" gas with Canada by utilizing existing lines and building others has been filed with FPC. . . .

CORROSION—N.A.C.E. hears of a new method of determining current density for storage-tank bottoms. . . . The advantage: You don't have to dig under the bottoms for tests any more. . . . ¶Symposium on storage and pipeline problems highligh N.A.C.E.'s Galveston conference. . . . The battle against this No. 1 plague of industry is continuing, with new weapons being developed constantly to combat it. . . .

PRODUCTION—Texas Railroad Commission trims April allowable 115,137 bbl. daily from March 15 figure. . . . This is the sharpest cut in Texas production since December 1950. . . . ¶More effective water-flooding projects will be realized if proper attention is given all factors which will affect success, A.P.I. hears. . . . ¶Amerada's suggested 80-acre spacing pattern in North Dakota is rejected in favor of 40-acre spacing. . . .

TRENDS—April production of crude and lease condensate is forecast at 6,325,000 bbl. daily. . . . ¶Crude imports are expected to average about 475,000 bbl. daily. . . . Allowing for crude exports, transfers, and losses, the new supply will support refinery runs of about 6,690,000 bbl. daily with no reduction in crude stocks. . . . ¶Refinery runs averaged 6,183,000 bbl. daily in April 1951. . . .

ACTIVITY—Production of crude and lease condensate averaged 6,412,000 bbl. daily for the week ended March 15, down 12,375 bbl. daily. . . . ¶Well completions for the week totaled 815, down 25 from the previous week. . . . ¶Wildcat completions dropped to 137 compared with 174 for the same week last year. . . . ¶Rotary rigs operating in United States on March 17 increased 51 rigs to 2,713. . . .

Oil Finders Meet

Scientific oil explorers to convene in Los Angeles this week for joint sessions of A.A.P.G., S.E.G., S.E.P.M.

LOS ANGELES.—In the midst of the greatest exploratory program in history, the nation's scientific oil finders gather here this week for the jointly held annual meetings of the American Association of Petroleum Geologists, the Society of Exploration Geophysicists, and the Society of Economic Paleontologists and Mineralogists.

The three groups, meeting at the Biltmore Hotel March 24-27, have scheduled 4 days of sessions for the discussion of technical problems in locating underground oil deposits.

Tuesday, March 25, is the joint-session day. Howard C. Pyle, A.A.P.G. conventional general chairman, will preside over this big meeting which will feature addresses by Eugene Holman, president of Standard Oil Co. (N. J.), and the outgoing presidents of the three societies: A.A.P.G.'s Frank Morgan, S.E.P.M.'s T. H. Philpott, and S.E.G.'s Sigmund Hammer. *(Addresses of Philpott and Hammer will be found in the special exploration section of this issue.)*

Honors, awards.—At this joint session the honors and awards for the past year will be presented. These include S.E.G.'s best-paper award and the bestowal of an honorary membership; A.A.P.G.'s Sidney Powers Memorial Medal and best-paper award; and S.E.P.M.'s award in recognition of services.

All other scheduled sessions are for the discussion of problems primarily of interest to the geologist, the geophysicist, or the paleontologist or mineralogist.

A.A.P.G.'s technical program, arranged by Leo Newfarmer, will deal with research subjects and the geology of some newly productive and future oil provinces.

The program of the S.E.G. arranged by Curtis Johnson, will include geophysical papers of general interest on Monday, when the other societies are not holding meetings. Wednesday the sessions will feature papers on basic geophysical research and instrumental and interpretive techniques.

S.E.P.M.'s technical program arranged by K. O. Emery, will cover objectives in modern sedimentology and paleontology and recent marine sedimentation.

Fractured reservoirs.—One of the highlights of the technical programs will be a symposium on production of oil and gas from fractured reservoirs. This symposium, arranged by E. A. Koester, chairman of the A.A.P.G. research committee, is certain to attract considerable attention because of the interest in the fractured Spraberry reservoir of West Texas. Papers at this symposium will cover a wide range of oil occurrences in fractured reservoirs. *(See abstracts of some of the papers to be presented, beginning on page 168 of this issue).*

Another special session will be S.E.G.'s "Safety and Geophysical Exploration" arranged by Bart W. Sorge, chairman of the society's special committee on safety.

Field trips.—A busman's holiday on a grand scale has been planned for the visiting scientists as they will have the opportunity to go on any of a number of field trips to observe the geology and operating methods in several of the areas of California most interesting from the standpoint of exploring for oil.

While all of these trips will be of general interest to the scientists attending the convention, four are primarily for the petroleum geologists and one each for the geophysicists and the paleontologists.

More Oil Will Be Found

Improved exploration technology is only one of several reasons why NPC committee is confident for the future

THE scientific advances represented by the members of the three exploration societies holding their annual meetings in Los Angeles this week are an extremely important but by no means the only reason why the United States is in no danger of running out of oil during the next generation or two.

This is demonstrated with unusual clarity in the report on present and future supplies of oil and gas recently issued by the availability committee of the National Petroleum Council. *(The Oil and Gas Journal, March 3, 1952, page 45).*

Why we will find tremendous quantities of oil in this country is explained in the report in a way which should give every oil man adequate information to answer the popular fallacy that our petroleum resources are being used up so rapidly that we should turn to government control, synthetic fuels, or some other artificial expediency.

The science of exploration, which is specially featured in this issue of The Oil and Gas Journal to coincide with the annual meetings of the three societies, has made it far easier to find oil than was the case a score of years ago.

But even more reassuring for the future, the NPC committee points out, is our understanding of the process by which oil is found, a process in which economies and psychology are factors fully as great as the technical aspects.

Two fallacies.—Two popular fallacies about the future oil supplies are effectively laid by the report:

1. Every oil field discovered reduces the possibilities of further discovery.

2. Proven reserves are a fair indication of the amount of oil available for the future.

Refuting those fallacies are these facts:

1. The more oil used, the more oil is found, and throughout its nearly 100 years the oil industry has found more new oil during a given period than it produced during that period.

2. Every new field discovered makes it easier to find still other fields because of its contribution to the knowledge of where to look.

3. Proven reserves are only the inventory of oil ready to be placed on the market within a relatively short time, and are in no sense a measure of the quantity which may be available at any future date. Reserves always are 10 or a dozen times annual production and keep increasing at substantially the same rate as production increases.

Why these things are so is explained in the report in an optimistic chapter on the long-term prospects for petroleum supplies.

Just starting.—In the first place, we have barely scratched the earth's surface searching for oil, and the areas where oil is possible but where we have not looked are tremendous. The prospective area in which the industry thinks oil and gas may be found is about 100 times as large as the area of all the oil and gas fields discovered in the United States, and our ideas as to the size of the prospective oil area have increased as a result of additional knowledge.

As geologists well know but the public poorly understands, about 2,-

400,000 sq. miles, or approximately 80 per cent, of the land area of the United States contains rocks of the type where oil may be found and about 1,860,000 sq. miles are considered favorable prospects. At the current rate of 10,000 exploratory wells per year it would take 50 years to drill one well in each 3 sq. miles of this area.

There are two other physical factors in addition to surface area. One is the increasing depth to which wells are being drilled. Each deep discovery opens new prospects of finding other fields at similar depths, often in the same location as shallow production.

The second is intensity of drilling and more careful examination of the producing possibilities of known formations. Many good fields have been found by more closely working over areas once passed up or by testing sands once thought unprofitable.

It is not true that the best prospects have already been tested, because the nature of the exploration process is such that some of the most prolific fields have been found in areas abandoned by earlier prospectors.

Probabilities increasing.—Technology, as applied by geologists, geophysicists, and paleontologists, is increasing the probabilities of locating oil in favorable prospecting areas. Knowledge of where oil may be found grows by the hour with the study of wells being drilled. Great strides are being made in the tools to hunt for oil, to reach it, and to locate its exact position in the earth.

Technology, too, is increasing the recovery of oil when found. Each advance in producing techniques which increases the percentage of oil brought to the surface adds to the probable future producibility of reservoirs already located.

The oil developed during the past 26 years is more than four times as much as was developed during the preceding 67 years of the industry's history, although the number of wells drilled was approximately the same in both periods.

Economic factors.—But economic factors play fully as great a part in the outlook for future oil supplies as the areas yet to be tested and the march of technological knowledge, the NPC report explains.

The quantity of oil discovered depends chiefly on the rate at which it is looked for, and the rate of exploration depends on two things: The national need for oil and the incentive for finding it.

This simple principle, so often overlooked by those who predict an imminent oil shortage, is really the basis of the committee's optimistic forecast that the more oil we use the more we will find. Give the oil industry the economic incentive of a hope for a fair profit, says the committee, and it will keep on finding as much oil as the nation will need for another 50 years or more.

In fact, the committee is so sure of this that it predicts that some new source of energy will make petroleum obsolete and unwanted long before all the oil in the earth has been discovered and brought to the surface.

More Drilling Needed

Additional wells, high rate of geological and geophysical activity are needed now, Donnell tells Wichita A.P.I. group

Ted Armstrong

WICHITA.—An increased rate of drilling and a high rate of geological and geophysical activity during the immediate future were called for here last week by J. C. Donnell, II, president of Ohio Oil Co.

Speaking before the Mid-Continent district meeting of the American Petroleum Institute's Division of Production, Donnell said that during the past 2 years the oil industry had failed to enlarge its margin of excess productive capacity, even with the greatest drilling program in history.

"It is clear then that our drilling program must continue to be increased—not only to provide a productive capacity adequate to meet rising demands but also to build up a larger margin of safety in terms of excess productive capacity," the A.P.I. production vice president said.

Intensify research.—In addition, he said, the industry must intensify its research to improve techniques of recovering more of the oil in place.

"Additions to reserves from progressive application of more scientific methods are just as valuable as those uncovered by the drill," he said.

"Under no conditions," he continued, "should we reduce our geological and geophysical activity." The lack of big additions to reserves after 1945, he said, apparently was due to the reduction in exploration work during the war years, and the results during the past 2 years should be attributed to a speeding up of the work immediately after the war.

Hits synthetics.—Donnell also criticized the "persistence of certain government personnel" in pressing for "alleged commercial synthetic-oil development."

"The petroleum industry has been acquainted for many years with the potentially great reserves of shale oil from the Colorado Plateau. It has favored and supported the experimental efforts of the U.S. Bureau of Mines, but even this most promising of alternative courses of liquid fuel shows costs which are as yet not competitive with natural petroleum," Donnell said.

SAVED FROM RUSSIA.—This 157-ft., 200-ton distillation tower soon will make aviation-fuel components at the Torrance, Calif., refinery of General Petroleum Corp. Originally fabricated during World War II for Russia, its lend-lease shipment was canceled in 1945. For 6 years it lay unused until General Petroleum engineers, faced with current steel shortages, found it and adapted it to meet their requirements at Torrance.

Exploration Gains Forecast

DENVER.—An influx of new operators into the Rocky Mountain area has brought predictions that geophysical activity in the region this year will be even greater than in 1951.

Comparatively mild winter weather in the Colorado-Wyoming sector of the province has kept most of the crews working. Despite severe weather in the northern areas, large numbers of geophysical crews are reported still in the Williston basin. The number is expected to increase considerably with the coming of favorable weather.

New areas of exploration in the Denver-Julesburg, Williston, and Uinta basins accounted for the majority of the new work last year.

Expenditures on geophysical operations in the Rocky Mountain area totaled more than $30,000,000. Petroleum Information, Denver, reports activity totaled more than 3,708 seismic-crew weeks and 593 gravity-crew weeks—up one-third over exploration in 1950.

SYMPOSIUM CHAIRMEN.—This group of symposium chairmen met with officials of the National Association of Corrosion Engineers at the annual convention in Galveston. Standing, left to right: D. C. Glass, Pure Oil Co., Chicago, director of N.A.C.E.; L. G. Sharpe, Humble Pipe Line Co., Houston; L. L. Whiteneck, Long Beach Harbor Department, Long Beach, Calif., new N.A.C.E. director; Allen L. Alexander, Naval Research Laboratory, Washington, D. C.; J. K. Deichler, Atlantic Refining Co., Philadelphia; H. E. Waldrip, Gulf Oil Corp., Houston; A. J. Liebman, Dravo Corp., Pittsburgh; and A. B. Campbell, executive secretary of N.A.C.E., Houston. Seated, left to right: Paul J. Gegner, Columbia Southern Chemical Corp., Barberton, Ohio; H. W. Schmidt, Dow Chemical Co., Midland, Mich.; Walter F. Rogers, Gulf Oil Corp., Houston, new vice president of N.A.C.E.; Robert L. Bullock, Interstate Oil Pipe Line Co., Shreveport, chairman of the technical-program committee of N.A.C.E.; and M. G. Fontana, Ohio State University, Columbus, new N.A.C.E. president.

Battle Against Corrosion

It is ever continuing, N.A.C.E. told, with new methods being tested to combat damage to pipe lines, storage facilities

Paul Reed

GALVESTON.—A new method for determining current density for storage-tank bottoms eliminates the necessity for digging under the bottoms for tests, members of the National Association of Corrosion Engineers were told here.

Efficiency of current distribution can be estimated by means of four terminal - resistivity measurements taken near the tank, according to Scott P. Ewing and J. S. Hutchinson, of Carter Oil Co., Tulsa.

Discussing the method before the symposium on pipe-line and storage problems at the association's eighth annual conference, they pointed out that this method has limitations in assuming that soil is the same at the measurement point as under the tank and also in overlooking the effects of coatings and foundation pads.

Another modified four - terminal measurement uses the tank bottom as one terminal for accurately measuring conditions under the tanks, they said.

The economic value of cathodic protection of tank bottoms is indicated by the fact that a tank bottom leak is usually more costly than a pipe-line leak.

Pipe-line studies.—The significance of studying pipe-line corrosion problems from the electrochemical and thermodynamic point of view, in addition to the currently prevailing electrical approach, received much attention in informal discussions.

This discussion was stimulated by some of the points raised by Roy V. Comeaux, Humble Oil & Refining Co., Baytown, Tex., who called attention of corrosion engineers to the quantitative effects of oxygen in corrosion and cathodic protection.

To stop corrosion completely, when pipe is in well-aerated soil, would take a large amount of current for cathodic protection, he said. Measures for retarding the diffusion of oxygen would help to reduce current requirements.

Those who questioned the value of electrochemical studies of pipe-line corrosion doubted whether they would lead to development of more economical corrosion - mitigation techniques than those based on electrical methods.

It is clear that cathodic protection applied by electrical techniques is firmly established as the predominant procedure for corrosion mitigation and the efficiency of cathodic protection is increased by coatings.

On the other hand, the proponents of a broader understanding through the electrochemical and thermodynamic approach were confident it would lead to identification of a larger number of conditions under which metals will corrode and be protected than would be recognized by any one simple criterion—such as pipe potential of —0.85 volt with respect to copper sulfate electrode, which is now commonly applied.

It was predicted that the electrochemical approach would induce development of new techniques to minimize the cost of corrosion mitigation.

Gordon N. Scott, consulting engineer, exemplified thermodynamic methods when he showed polarization curves of a new type to describe a technique for determining cathodic-protection requirements. This innovation has been applied in recent years in certain studies in California.

Systematic methods for discovering the extent of electric interference between crossing structures were discussed by John M. Pearson, Sun Physical Laboratories.

Aluminum pipe.—Inspection of aluminum pipe in a submarine pipe line after 20 months' service showed that interior and exterior surfaces were in excellent condition, according to

E. T. Wanderer, Aluminum Co. of America, New Kensington, Pa., who asserted that aluminum pipe has possibilities for offshore pipe lining.

Concrete jacketing has been found to slough off buried steel pipe lines when subjected to excessive electric currents, according to W. R. Schneider, Pacific Gas & Electric Co., Emeryville, Calif.; and David Hendrickson, East Bay Municipal Utility District, Oakland, Calif.

The important functions of coatings in corrosion mitigation was emphasized to an increasing extent in discussions. Coating of entire lines was widely advocated. In high-resistant soils where cathodic protection is least effective, much reliance must be put on coatings. Furthermore, the electrochemical approach to corrosion induces attention to the value of coatings.

Cold applications of coating to steel pipe were regarded as impractical except in certain cases cited where such coating had been reinforced with a glass wrapper.

Round-table discussion.—The round-table discussion of pipe-line and underground corrosion was conducted by O. C. Mudd, Shell Pipe Line Corp., Houston, with Kirk H. Logan, Cast Iron Pipe Research Association, Washington, D. C. Questions were answered by Gordon N. Scott, consulting engineer, Los Angeles; Hugo Wahlquist, Ebasco Services, Inc., New York; J. Paul Oliver, Union Carbide & Carbon Co., Cleveland; Starr Thayer, consulting engineer, Houston; Marshall E. Parker, Jr., consulting engineer, Houston; W. E. Huddleston, Huddleston Engineering Co., Bartlesville, Okla.; H. N. Hayward, University of Illinois, Urbana; John M. Pearson, Sun Physical Laboratories, Newtown Square, Pa.; Scott P. Ewing, Carter Oil Co., Tulsa; H. A. Robinson, Dow Chemical Co., Midland, Mich.; and R. M. Wainwright, University of Illinois, Urbana.

A feature of the conference was the exhibition of equipment and material on Pleasure Pier. In 1953 the N.A.C.E. convention will be in Chicago.

Honorary awards were conferred for distinguished accomplishments. Earl A. Gulbransen, advisory engineer to Westinghouse Research Laboratories, East Pittsburgh, Pa., received the Willis Rodney Whitney Award for achievement in the field of corrosion science, and Starr Thayer, consulting corrosion engineers, Houston, received the Frank Newman Speller Award for achievement in the field of corrosion engineering.

New officers.—Officers and directors elected by the association are: president, M. G. Fontana, Ohio State University, Columbus; vice president, Walter F. Rogers, Gulf Oil Corp., Houston; treasurer, R. A. Brannon, Humble Pipe Line Co., Houston; executive secretary, A. B. Campbell, Houston; and directors: Hugh Goddard, Aluminum Laboratories, Kingston, Ont.; V. V. Kendall, National Tube Co., Pittsburgh; Norman Hackerman, University of Texas, Austin; and L. L. Whiteneck, Long Beach Harbor Department, Long Beach, Calif.

Unique Pipe Line

Gulf Interstate's proposed 1,000-mile, 30-in. carrier would move gas on a fee basis for United Fuel Gas Co.

Paul Reed and Walter Rose

HOUSTON. — A 1,000-mile, 30-in. transmission line, to handle natural gas entirely on a fee basis, is proposed from the Gulf Coast to northeastern Kentucky by the newly formed Gulf Interstate Gas Co. of Houston.

Purpose of the project will be to move the gas for United Fuel Gas Co., a subsidiary of Columbia Gas System, Inc., of New York.

The new pipe-line company was formed by a group of Panhandle Eastern Pipe Line Co. and Trunkline Gas Co. officials, and is headed by Hy Byrd, who is also president of Trunkline.

Gulf Interstate's project is unique in that it will be the first large line to transmit natural gas entirely on a fee basis without ownership of gas handled. Columbia's undertaking is significant as a far-sighted effort of an established eastern gas system to directly procure reserves in the Southwest for future needs.

The pipe line initially will tap upwards of 375,000,000 cu. ft. daily of presently uncommitted Texas and Louisiana Gulf Coast gas reserves to feed the large and expanding market demands of the Columbia system in West Virginia, Kentucky, Virginia, Ohio, Pennsylvania, Maryland, and New York.

An estimated expenditure of approximately $100,000,000 will be required for the construction of the line which will be approximately 1,000 miles long.

Seeking reserves.—At present Columbia's subsidiary, United Fuel Gas Co., is negotiating gas-purchase contracts in the Gulf Coast area for sufficient reserves to justify application by Gulf Interstate to the Federal Power Commission for permission to construct the line. To this end, the affiliated Columbia Gas System Service Corp., with Irving K. Peck as vice president, is being established in the City National Bank Building here.

Byrd asserts that FPC application will be made as soon as the reserves are assured, and that planning for pipe-line construction will commence immediately after the FPC approval is granted.

For providing large amounts of gas needed for future requirements, Columbia expects that it will be advantageous to purchase gas directly in the Southwest as well as to draw from the gas reserves of other existing transmission companies.

Big commitments.—Columbia already has large and growing marketing commitments in the areas they now supply. For example, during peak-load days of 1951 the system was delivering to industrial and domestic users 2.7 million cubic feet daily.

It has been asserted by George S. Young, president of the parent Columbia company, that the proposal to make use of gas-transport services of Gulf Interstate will in no way diminish efforts to augment supplies to be obtained from other gas-transmission companies and eastern gas producers. It is Columbia's objective to strengthen its position as a major marketer of gas in its important eastern markets, by so improving its gas-supply situation.

Columbia has no intention of having a financial interest in Gulf Interstate and wishes to avoid ownership and responsibility for constructing and operating a long trunk-line system. The Gulf Interstate system will serve only Columbia's needs and there is no intention of transmitting for other interests.

Construction plans.—Construction will commence immediately after the granting of an FPC permit to Gulf Interstate. It is anticipated that construction will continue over two summers.

As yet, there is no indication of the length of time which will be taken in acquiring sufficient reserves to justify the Gulf Interstate project. For the next 3 to 5 years, 350,000,000 to 525,000,000 cu. ft. daily of additional gas will be needed by Columbia. It does not propose to enter the exploration and producing business in the southwest, and all gas will be purchased.

The routing of the Gulf Interstate line will not be determined until gas has been contracted. Engineering will be done by the Trunkline organization, but plans for equity financing of Gulf Interstate have not yet been made.

Officers.—At present, there are only two officers of Gulf Interstate: Byrd as president, and G. M. Woodfin, secretary, who is attorney for Trunkline. Directors are Byrd and Panhandle Eastern officials including W. G. Maguire, chairman of the board of direc-

tors; E. Buddrus, president, and L. B. Watkins, secretary-controller.

The Columbia Gas System, Inc., headed by Stuart M. Crocker, chairman of the board, and George S. Young, president, is engaged in serving a large industrial and metropolitan area through a group of subsidiaries, of which the largest are United Fuel Gas Co. (Charleston group), Ohio Fuel Gas Co. (Columbus group), and Manufacturers Light & Heat Co. (Pittsburgh group).

Large cities served, either directly or indirectly, through wholesale customers, include: Cincinnati, Dayton, Toledo, Columbus, Pittsburgh, Binghamton, N. Y.; Baltimore, Washington, D. C.; and Huntington and Charleston, W. Va.

"Crooked Holes"

They are often more efficient and cheaper to drill than "straight" holes because contracts are not "realistic"

Ted Armstrong

WICHITA.—"Crooked holes" often are more efficient and more economical than "straight holes," according to the current definitions of these terms.

There are cases where an allowable deviation of 7° from vertical would save $30,000 per well compared with a hole drilled in accordance with contract terms calling for a 5° limit to deviation, R. B. McCloy, Stanolind Oil & Gas Co., Oklahoma City, told the Mid-Continent district meeting of the American Petroleum Institute's Division of Production here last week.

Present drilling contracts are not realistic, McCloy suggested, since they define crooked holes only by their angle of deviation from the vertical.

Actually, he said, many changes in direction and a number of changes in the rate of deviation can cause real drilling hazards and increased production expense, even if the hole meets contract requirements as to the angle of deviation.

Keyseat cause.—Radical changes in direction will cause keyseats if the rocks are not sufficiently hard and the depth is appreciable, McCloy said. If the rocks are too hard to permit keyseating, he added, direction changes will result in excessive drill-pipe wear.

Further, McCloy said, there will be appreciable rod and tubing wear during producing operations at the points of rapid change in direction.

Popular drilling contracts contain clauses limiting deviation to a maximum of 3° or 5°, he said, but specification of drift angle alone does not obtain the results most operators desire and believe they are providing for—a hole that is reasonably straight and therefore economical.

Clause inadequate.—"It is hoped," McCloy continued, "that the industry will realize that the deviation clause as now used does not, as many believe, assure a particular type hole or one that is reasonably free from drilling or producing difficulties."

To support his contention, McCloy cited two wells, both drilled in Stephens County, Oklahoma.

The first recorded a maximum deviation from vertical of 2¾°, with all other readings of 2° or less. However, he said, there were many changes in direction and the changes in vertical deviation were sharp.

The second recorded a deviation from vertical of as much as 6½°, but the changes in direction were slight and there were no rapid changes in the angle of drift. "This well was drilled with no drilling difficulties and it is anticipated that producing operations will not be as expensive as the first well," McCloy said.

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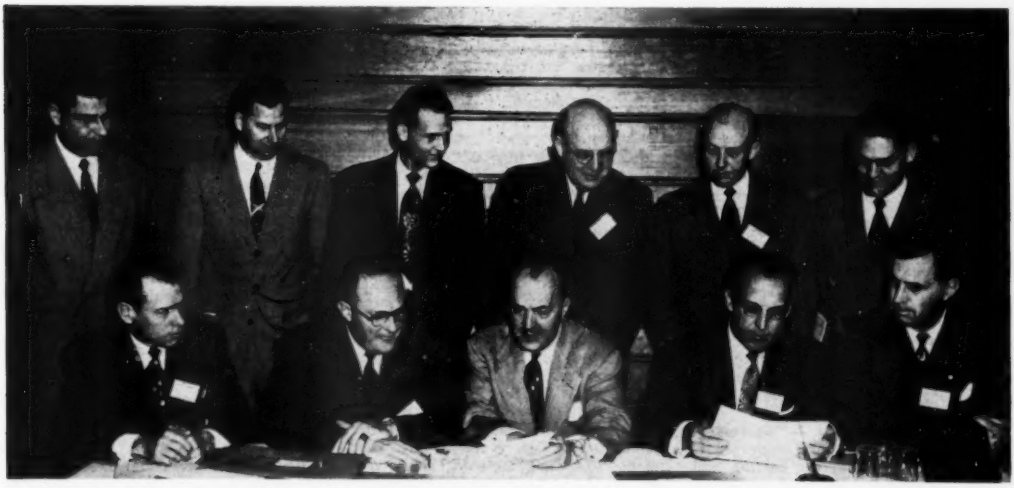
Costs lower.—Actual drilling cost of the second well was lower, he said, since the nature of the deeper formation would have slowed drilling considerably had the contractor been required to keep the hole within the usual 3° deviation limit.

A study of two wells on diagonal 10-acre locations in Carter County, Oklahoma, also bore out the need for a new definition of a crooked hole, McCloy said.

"One well was drilled with a maximum allowable deviation of 5°; the



STUDY COMMITTEE.—Artificial lifting of deep wells was under discussion by this group as this picture was taken at the A.P.I. production meeting in Wichita. Seated, left to right, are Leo W. Fagg, Johnson-Fagg Engineering Co., Tulsa; O. L. Nuernberger, Shell Oil Co., Tulsa; J. Zaba, Stanolind Oil & Gas Co., Tulsa, committee chairman; Wayne C. Moody, Sunray Oil Corp., Tulsa; and Ross M. Stuntz, Gulf Oil Corp., Tulsa. Standing are Chesler Burk, Continental Oil Co., Oklahoma City; A. H. Ilfrey, Humble Oil & Refining Co., Houston; Roy M. Willis, Atlantic Refining Co., Dallas; L. A. Ogden, Pure Oil Co., Tulsa; Douglas Johnson, Johnson-Fagg Engineering Co., Tulsa; and Nestor Jaramillo, Cardwell Manufacturing Co., Wichita.

other was allowed 7 . The over-all saving on the 7 well was $30,000 or, based on the estimated ultimate oil recovery, 13 cents per barrel.

"A comparison of two other wells in the same area indicated a savings of $10,000 or, based on the estimated oil recovery, a saving of 7 cents per barrel."

"These possible savings are often overlooked," McCloy said, "when compared to the total cost of drilling a well.

"A saving of $10,000 in the cost of drilling well represents a saving of 10 cents per barrel on a well that recovers 100,000 bbl. of oil, or a saving of 1 cent per barrel on a well that recovers 1,000,000 bbl. of oil. Either saving is appreciable when compared to the items under consideration on a lifting-cost statement."

Better Water Floods

If proper attention is given factors which will affect success, fewer mistakes will be made in selecting pools

Gerald L. Farrar

WICHITA.—Fewer mistakes will be made in selecting pools for water flooding if sufficient attention is given the important factors which will affect its success.

"The average operator can screen out water-flooding projects which have little opportunity for profitable operation," W. W. Wilson said here before the Mid-Continent district meeting of the American Petroleum Institute's Division of Production.

Factors which should be evaluated before attempting a water-flooding project were outlined by Wilson in a paper authored jointly with C. L. Brown and K. D. Sheppard, all of Continental Oil Co., Ponca City, Okla.

These include the method of primary production, residual oil saturation, connate water, structural relief, lenticularity, porosity, permeability, and the possible production rate.

Economic considerations include the amount of reserves remaining, operating costs, lease and royalty problems, and development expense, the authors said.

Reservoir selection. — "Solution-gas-drive reservoirs offer the best possibilities for water-flooding operations because of favorable relative permeability and oil-saturation conditions after primary depletion," Wilson pointed out.

Water-drive reservoirs are generally unsuited, Wilson said, due to high water and low oil saturations at the end of the primary phase.

Both gravity drainage and gas-cap-expansion reservoirs are unsatisfactory due to difficulties in packing off upper barren sections and to the danger of vertical fluid movement.

Unfavorable conditions. — "Successful water flooding cannot be expected if any major portion of the section has an oil saturation less than about 35 per cent," Wilson declared.

High relative permeability to water usually causes serious bypassing or channeling of injected water, he said. He emphasized that average oil-saturation values for entire reservoirs are "generally without significance," since oil saturation of the more permeable zones may be much lower.

Reservoir features. — "It is doubtful that a successful flood will result when water saturation exceeds 45 per cent," Wilson said in speaking of connate-water content.

"If there is evidence of production from a water-bearing zone in the reservoir it will be necessary to isolate this section in all injection wells to prevent channeling and the loss of an appreciable portion of the injection water," he added.

Reservoirs with little structural relief are desirable for pattern-type floods to minimize gravity segregation and vertical fluid movement. If reservoir dip is greater than 10 degrees, peripheral flood may allow greater control of fluid movement, the authors suggested.

Moderate lenticularity in the pay formation is probably conducive to successful flooding, while excessive lenticularity will result in substantial trapping or bypassing otherwise-recoverable oil, they continued. Reservoir lenticularity can usually be determined from well logs and isopachous maps.

"Sandstones and granular limestones comprise the vast majority of formations which have been flooded successfully," Wilson reminded the audience. While little information is available, he said, it is apparent that "many fractured reservoirs would be poor flooding prospects" because of bypassing.

Ideal subject for water flooding, Wilson concluded, would be "a reservoir in which all the productive zones were of the same horizontal permeability." "Extremely erratic permeability profiles generally result in prolonged production periods of high water-oil ratio, followed by abandonment before all of the sand has been flooded," he said. While certain methods may be employed to compensate partially for erratic permeability, these are only partially effective.

Reservoir depth has a direct bearing upon maximum sand-face pressure which can be applied without rupturing the formation. This pressure varies between 0.5 and 1.5 psi. per foot of depth. Shallow, tight sands are thus often impracticable to flood, while deep sands can be flooded at high pressures. Optimum flooding depths usually range between 500 and 3,000 ft. for reservoirs having average sand conditions.

Old-well dangers.—Use of old wells can result in many difficulties, the authors agreed.

There are many sources of trouble in using them. Deposits on the sand face may plug the exposed formation. Incomplete penetration of formation, excessive injection rates, presence of exposed barren zones which channel off large quantities of water, and improper well abandonment are other troublesome factors.

Economic requirements.—To be a successful flood, the pool must have sufficient reserves to justify the project. If evaluations of the other factors prove favorable, the authors advised a coring program and the operation of a pilot flood to determine further the reservoir's potentialities.

Sources of suitable water and necessary power for operations also should be evaluated, they agreed. It should also be borne in mind that larger pumping units might be needed, particularly if the lease has been operated with small units or central power and jacks, they said.

As flood operations continue, water-oil ratio of production and replacement of equipment increase, according to Wilson. These factors, he said, result in a continually increasing lifting cost per barrel of oil.

Outlook Bright

Next decade will see new oil gains, Peake predicts

NEW YORK.—Moderate but continued growth in domestic oil demand over the next decade was predicted here by A. W. Peake, president of Standard Oil Co. (Ind.).

The good long-range market will be adequately supplied by industry through continuation of large capital expenditures, he told members of the New York Society of Security Analysts.

The present high level of consumption is not a temporary condition, said Peake.

"Our estimates of domestic consumption for 1952 anticipate a further growth over 1951 of 5.4 per cent. Total demand should increase by 3.4 per cent even though exports are expected to decline. Our economists are of the opinion that domestic demand will increase by 30 per cent over the next 10 years."

This estimate is based on studies of population growth, home building, industrial expansion, cars in use, and

other transportation needs requiring gasoline, diesel fuel, and bunker fuel.

Peake estimated 1952 increases over 1951 at 6.6 per cent for gasoline, 6.6 per cent for kerosine, 6.4 per cent for distillates, 1.4 per cent for residual, and 6.7 per cent for all other petroleum products.

Indiana Standard and its affiliates will share at least proportionately in this expanded market, he predicted. This year the consolidated company's bill for capital outlay will exceed $200,000,000. They expect to pay for this without adding to their debt.

Investments up.—During the postwar period 1946-51 inclusive, the company and its affiliates invested $1,076,000,000 in new facilities, of which 44 per cent was earmarked for production, 23 per cent for manufacturing, 18 per cent for transportation, 10 per cent for marketing and 5 per cent for other facilities.

Research and development investments have almost tripled during the period and this year will be well in excess of the $12,291,000 spent last year, Peake said. Total research and development outlay for the 6-year period was about $52,700,000.

Since 1946, refinery capacity operated by Standard of Indiana, Pan American Refining Corp., Pan-Am Southern Corp., Utah Oil Refining Co., Mexican Petroleum Corp., and Stanolind Oil & Gas Co., has expanded 54 per cent compared with a 30 per cent industry-wide capacity expansion over the same period.

This refinery growth required an investment of a quarter billion dollars in new refining facilities. During the same period, company production of crude and natural-gas liquids increased 47 per cent while natural gas production jumped 162 per cent.

Approximately 30 per cent of the consolidated company's natural-gas reserves are now dedicated, Peake said.

New refinery.—In addition to several construction projects now under way in refining and transportation, Peake cited the new North Dakota refinery the company will build and a products pipe line which will be laid from Whiting, Ind., to Detroit.

The line will not be undertaken this year, but is a relatively near-future project. Stanolind plans to drill from 6 to 10 wildcats this year in the Williston basin, and although no commercial production has yet been brought in in Canada, the company plans to continue exploration on its 300,000 to 500,000-acre holdings in the prairie provinces of that country.

Engineers as Managers

They can reach that goal in the petroleum industry if they have other skills in addition to engineering ability

Henry D. Ralph

NORMAN, Okla. — More engineers are needed in the upper ranks of management of oil companies, but to qualify for a management position an engineer must have a great many skills in addition to engineering ability.

This was the concensus of the Petroleum Engineering - Management Conference held by the University of Oklahoma March 14-15 at which a group of the industry's prominent engineer - managers discussed what qualities are needed for successful management and how to develop these qualities in men with engineering training.

It was, so far as anyone could recall, the first public conference ever held on the place of engineers in management, and the more than 200 industry men who attended from throughout the Mid-Continent considered it so constructive that it probably will be repeated another year.

It was unique in that the officials of the College of Engineering who planned the program avoided the subjects commonly discussed at symposiums on management problems, such things as wages, hours, grievance procedure, and collective bargaining. Instead, the topics dealt with broad aspects of management's responsibility to scientifically trained personnel and what engineers, geologists, and chemists must do if they aspire to management positions.

Warning sounded.—Beware of "overengineering," was a warning sounded, in one way or another, by virtually all the speakers who had risen to top management from engineering positions.

By this they meant too much specialization, equipment too perfect for the job at hand, emphasis on scientific idealism to the exclusion of practical aspects, and in general a failure to see the problems of the company —and of the industry—fully and as a whole.

It was Edgar Kraus, chief engineer of Atlantic Refining Co., Dallas, who used the term "overengineering." He was referring to a finely worded-up proposal to purchase a producing property or to install a secondary-recovery project, and he explained that too frequently such a report exhibits overspecialization and lack of perspective because the engineers who drew it ignored economic factors and failed to evaluate the project in the light of the company's over-all position and policy.

The same thought was expressed by D. V. Carter, chief engineer of Magnolia Petroleum Co., Dallas, in the phase "recovery is the payoff," by which he meant that the most perfect engineering program is useless unless it will recover enough oil and enough capital to make it attractive from the standpoints of conservation and economics.

These were examples of why technically trained men do not always make good managers—a point stressed by every one of the speakers.

Two classes.—E. DeGolyer of Dallas, called the "dean of the world's oil finders," pointed up this thought by dividing technically trained men into two classes: Technicians, who are skilled in a particular technique of applying science to a practical art, and technologists, who are concerned with coordinating and directing the work of a whole group of technicians in a given field.

This was carried a step further by Carl E. Reistle, manager of production of Humble Oil & Refining Co., Houston, who defined the engineer-manager as a catalyst who takes scientific information and reduces it to action, who has "the art of doing with $1 what anyone can do with $2."

High aspirations.—More than half of all engineers aspire to be managers, according to Frank H. Willibrand, manager of production of Sohio Petroleum Co., Oklahoma City. But, he added, so do the lawyers, economists, accountants, and men in other professions, so management is faced with the problem of selecting for advancement the most well-rounded men of whatever professional origin.

The requisites of an engineer-manager were variously described by several speakers, but there was unanimity that he must be economic minded, understand people, and practice good public relations.

Eugene McElvaney, vice president of the First National Bank in Dallas, was only one of several speakers who stressed the importance of a broad knowledge of economics and the importance of viewing every engineering project or decision in the light of the company's financial position, return on investment, and the tax situation. The evaluation of property cannot be based solely on an engineering formula or there would be no need for management, for management is not an exact science, he said, and management both supplements and complements the engineer.

Where so many engineers fail as managers is in the field of human relations, it was stressed, because successful management must employ the forces of people whereas engineers often are trained to eliminate the human equation. The successful manager has an indefinable quality

of personality which enables him to work in harmony with his associates and to inspire others to work as a team.

Public relations.—Significantly, perhaps, greatest stress was put on the need for good public relations. Frank M. Porter, president of the American Petroleum Institute, said that one of the greatest needs facing the oil industry today is technical men who can explain the complicated problems of the industry to the public and make people understand what they mean. DeGolyer explained how good public relations are imperative in foreign oil operations and that there, even more than in the United States, the lowest-grade technician must be an ambassador of good will.

Kraus backed them up by declaring that management is facing a problem of getting better understanding by the public, not through press releases, advertising, or lobbying, but through the daily contacts with people by all employes of the company. Reistle made much the same point when he said that one of the major reasons for engineers failing to advance into management is their lack of ability to express their conclusions and to convey them to others.

Harold B. Fell, vice president of the Independent Petroleum Association of America, added the thought that the engineer-manager has a responsibility to the public to take an active part in the affairs of federal, state, and local governments and of state regulatory bodies, and to make sure that political conditions are such that the industry can continue to function to provide adequate supplies at all times.

How to develop the desired management qualities in engineers was the subject of a great deal of discussion. Without exception, every one of the engineers on the program urged the colleges to turn out fewer highly specialized technicians and then devote more attention to the broad fundamentals of science and to economics, sociology, psychology, and study of the humanities.

It makes little difference to management what kind of engineering, chemical, or geological schooling a man had if he has a broad grounding in science, has learned all aspects of the business, and can handle people, it was asserted.

Company responsibility.—But the companies, too, have a great responsibility in training engineers for management, all agreed. First they must teach a young engineer the details of all operations of the business and then they must "unscramble the specialists" by working them into the legal, economic, and human-relations problems of the company through committee assignments, decentralization of authority, and similar devices so that management will not be all "top side" but will be spread down into the operating level.

Engineers have greater opportunities than ever to get into management because capital is seeking engineers with management know-how, so large companies are faced with a serious problem of keeping their technical men, several speakers pointed out. To do this, it was agreed, engineers must be treated as builders rather than caretakers and must be given a feeling of belonging and of accomplishment.

A.I.Ch.E. Symposium

Atlanta group discusses pilot-plant-temperature control, recovery of sulfur from natural gas, and market research

ATLANTA. — Pilot-plant - temperature control and recovery of sulfur from natural gas shared attention with a symposium on market research at a meeting of the American Institute of Chemical Engineers here.

T. G. Stack and J. E. Friden of the research department of Standard Oil Co. (Ind.), Whiting, reported on a highly effective installation for maintaining close-temperature control in pilot-scale equipment.

The system employs Dowtherm A and is used to control temperatures in several reactors through the range 125°-650° F. This liquid medium is circulated in two streams, hot and cold. Each is circulated in essentially independent heating and cooling systems.

By means of automatic blending of the two streams, process-vessel temperatures may be held to variations of 3° F. or less for the noted temperature range.

The hot Dowtherm-stream temperature can be controlled within 1 per cent by a gas-fired heater. The cold-stream temperature is depressed by a water-cooled exchanger.

Process vessels are connected in parallel between Dowtherm lines, and are manifolded to both systems. Cold-stream circulation is adjusted manually and generally remains constant for any particular operation.

The desired temperature is maintained by automatic throttling of the hot stream by means of an instrument-controlled solenoid valve which can be opened for periods ranging from 1 second to 60 seconds per minute.

Heater.—The heater supplies Dowtherm at 325°-650° F. and will furnish up to 300,000 B.t.u. per hour heating Dowtherm from 600° F. to 650° F. It will operate satisfactorily at a minimum demand of 25,000 B.t.u.

The water-cooled exchanger, comprising three tin-tube sections in series will remove 100,000 B.t.u. per hour cooling 10,000 lb. of Dowtherm from 150° F. to 125° F. with inlet and outlet water temperatures of 75° F. and 85° F. respectively.

The system which has seen 3 years' satisfactory operation, is designed to control exothermic as well as endothermic reactions. A larger system has been designed to furnish hourly heat input of 1,000,000 B.t.u. and removal of 500,000 B.t.u.

Sulfur recovery. — Sulfur in vapor phase is composed of a number of molecular species, and the relative amounts of these species are affected by pressure and temperature, reported E. R. McCartney and A. L. Kohl of Fluor Corp., Ltd.

As a result of this association of sulfur atoms into heavier molecules, or disassociation into lighter ones, the number of mols present in a given mass of the element affects every thermodynamic calculation involving the gas.

The authors state that sufficient theoretical and practical data are now available to enable the design of plants for the recovery of elemental sulfur from H_2S to be undertaken on a rational basis.

Conversion efficiencies attainable by alternate-flow schemes can be predicted with reasonable accuracy and the relative merits of the proposed schemes can be evaluated by an economic study.

Using equilibrium constants calculated from free-energy data, conversion curves may be drawn for individual cases. Each case must be computed individually since the varying presence of water or inerts in the feed gas change the shape of the conversion curve.

In general the highest conversion is obtained at low temperature. The dew point of the sulfur marks a limit beyond which the temperature in the catalyst bed must not be lowered. Dew points are functions of sulfur partial pressure and not total system pressure.

Market research. — An all-day symposium on market research attested the importance which chemical engineers today attach to that new phase of chemical development.

Ten papers authored by representatives of the country's leading chemical companies discussed the means of arriving at answers to three questions concerning prospective chemical products:

1. How much of this product can be sold?
2. How much of this market can we get?
3. What competition do we face?

M. W. Leland of Shell Chemical Corp. described the job as complex

and difficult, involving an understanding of the multiplicity of chemicals and uses and the assessment of product potentials in an industry where new processes, new uses, and new products are frequent occurrences.

Dispute to WSB

Oil's labor difficulties set for study this week

WASHINGTON.—The Wage Stabilization Board is expected to take up the oil and gas industry's labor dispute this week, provided it disposes of the steel wage controversy which has been before it for some weeks.

The entire board has been devoting its time to the steel problem, which must be settled promptly if a paralyzing strike is to be averted, and has been unable to do anything more than set its staff to work compiling information on the oil industry's situation.

The White House last week sent the board a list of more than 100 oil and gas facilities in which wages were under discussion, to supplement the original list of eight companies in the President's letter of March 6, handing the problem to the board.

Telegrams have been sent to the officials of those plants and O. A. Knight, president of the O.W.I.U., and J. J. McKenna, representing the independent unions, asking that normal working schedules and production be maintained.

No wires to A. F. of L.—Although the A. F. of L. has been participating in the discussion of union strategy with the C. I. O. and independent unions no telegrams were sent to it. A spokesman for the board explained that the mediation and conciliation service is studying the matter to see if any A. F. of L. unions are involved.

A large number of the companies, as well as Knight and McKenna, have responded to the telegrams with assurances that operations would continue.

I.P.E. Dates Set

Exposition will be held in Tulsa on May 14-23, 1953

TULSA.—The International Petroleum Exposition definitely will be held in Tulsa May 14-23, 1953, and the I.P.E. executive committee has been assured of a large attendance by personnel of oil companies and drilling contractors.

Following the committee's initial recommendation that the oil show be held next spring, some objections were raised that oil operators would be too busy to attend in large numbers, and some of the exhibitors suggested postponement to 1954.

The announcement that the exposition is definitely scheduled for 1953 was made by W. G. Skelly, president of Skelly Oil Co. and president of the I.P.E., following surveys to determine the extent to which the show is desired and the extent to which it will be attended.

"Considerable sentiment to postpone the show had been expressed by a number of the larger exhibitors," Skelly said. "They doubted the ability of some firms to have equipment to exhibit and also whether oil companies and drilling contractors would be able to send their field personnel to the show in view of the increased number of wells the Government is asking the industry to drill in 1953."

Survey made.—Skelly said that he and E. F. Bullard, president of Stanolind Oil & Gas Co. and also a member of the I.P.E. executive committee, have surveyed a large sample of oil companies and drilling contractors and found they intend to send in their field personnel in large numbers to see the exhibits.

Skelly also pointed out that medium and small sized exhibitors definitely want the show by a large majority.

Attendance at the last oil show held in 1948 showed representatives from 43 countries outside the United States and 29 states within the United States.

CANADA

Tar-Sands Venture

Swedish firm, five Canadian oil companies to undertake "heat" extraction of Alberta's huge Athabasca deposit

EDMONTON, Alta.—A two-pronged attack to extract oil commercially from the world's largest known oil reserves, the Athabasca tar sands in northeastern Alberta, has been announced by N. E. Tanner, minister of mines and minerals of the Alberta government.

Underlying about 30,000 sq. miles along the Athabasca River, the sands have been estimated to contain 250 billion barrels of oil. To date, no oil companies have considered that it can be extracted economically in competition with oil in conventional formations.

Tanner said the Alberta government has made a deal with a Swedish firm for introduction of an "in situ" process of extraction involving underground combustion.

He also announced that five Canadian oil companies have been granted reservations totaling 250,000 acres in the best-known section of the oil sands area.

Participants.—The Swedish firm is Swedish Shale Oil Co. Representing the company in Canada are Hans Lundberg and Dr. Gosta Salomonsson, who have visited the province several times in recent months in connection with taking over the government's pilot plant at Bitumont.

The five Canadian companies, with separate leases each covering almost 50,000 acres of land, are: Calvan Consolidated Oil & Gas Corp., Asher Oil Co., Pacific Petroleum, Ltd., New Continental Oil of Canada, and Charter Oils.

Process.—Tanner said the Swedish company will attempt to extract oil from the sands by a "heating process" said to be in use in Sweden on oil-shale deposits. The minister said he could not now reveal details of the European process.

The Swedish concern already has paid the government $25, plus a $1,000 deposit for the license required before any group may enter the area, and has made a $25,000 deposit for use of the government plant. If it takes out a reservations after experiments, it will make a $50,000 deposit.

Tanner said the applications of the five Canadian firms were made separately but that the five can carry out a joint program if that is their plan. They have made the necessary cash deposits, totaling more than $250,000, and the applications have been accepted and are being prepared for official release.

Tests scheduled.—This summer, the five will undertake a program of systematic core drilling to determine the amount of overburden above the productive formation, the thickness of the sand itself, and its petroleum content.

Their reservations are in the Mildred Ruth Lake district, opposite the Bitumont plant, which is about 250 miles northeast of Edmonton.

After experiments with a hot water flotation process, the government announced in 1950 that it had solved the extraction problem. In January 1951, a report for the government by Sidney M. Blair, petroleum consultant of Toronto, stated that the oil could be produced and marketed commercially from the sands. Blair found that a product worth $3.50 a barrel could be laid down at Superior, Wis., for $3.10 a barrel.

Texas Allowable Cut

April figure set 115,137 bbl. daily below March 15

AUSTIN.—The Texas Railroad Commission has set the state's crude-oil-production allowable for April at 3,044,340 bbl. daily, a reduction of 115,137 bbl. daily from the allowable in effect on March 15.

The cutback will result from a producing schedule of 22 days for the state generally and 19 days for East Texas field in a 30-day month compared with 24 days generally and 19 days for East Texas in March, a 31-day month.

On the present basis the March 15 allowable was 3,159,477 bbl. daily, with actual production estimated at 2,289,000 bbl. daily.

No reason given.—No reason was given for the cut, but testimony from several purchasers at the hearing indicated that production is in excess of market demand and that both crude and product stocks are at comfortable levels for this season of the year.

Several operators had requested increases in the allowable, stating that refinery runs, although up, were well in hand, and that demand should remain high enough to make the increase justifiable.

The Bureau of Mines estimated demand for Texas crude during April at 2,850,000 bbl. daily, unchanged from March.

The following table shows the allowable by districts for April in barrels daily compared with allowable as of March 15:

	Allowable for April	Allowable as of Mar. 15	Change
Dist. 1	37,533	38,168	— 635
Dist. 2	166,124	174,761	— 8,637
Dist. 3	499,245	517,894	— 18,649
Dist. 4	273,346	285,041	— 11,695
Dist. 5	64,787	67,497	— 2,710
Dist. 6 (outside E. Tex. field)	124,356	130,106	— 5,750
Dist. 6 (E. Tex. field)	277,544	269,073	+ 8,471
Dist. 7-B	107,091	110,800	— 3,709
Dist. 7-C	139,991	146,265	— 6,274
Dist. 8	1,051,214	1,110,944	— 59,730
Dist. 9	203,589	209,396	— 5,807
Dist. 10	99,520	99,532	— 12
Total	3,044,340	3,159,477	—115,137

Cogdell Injection Proposed

AUSTIN.—Sixty per cent of the natural-gas intake from Cogdell field in Kent and Scurry counties, West Texas, will be available as residue for injection purposes if such a proposal is granted, members of the Texas Railroad Commission were told here.

E. C. Rach, consultant for The Texas Co., said that when the company's Fuller gasoline plant and injection facilities are finally completed, about 10,000,000 cu. ft. of the 17,000,000 cu. ft. of gas produced daily from the field will be available for the injection program.

The company wants to inject the gas into the Canyon Reef formation of the field.

The Fuller plant is presently gathering 17,000,000 cu. ft. daily. The gas-injection facilities will have a capacity of about 14,000,000 cu. ft. daily.

In outlining its proposal for a gas-injection program for the Canyon Reef horizon of the field, C. J. Ray, another spokesman for Texaco, said there is no evidence of a water drive in the field. He said production to date has been under fluid expansion, and that future recovery will be due to a solution gas drive. Bottom-hole pressure, originally 3,100 psi., is nearing the bubble point estimated at 1,800 psi., Ray said.

Spraberry Ceiling Raised

MIDLAND.—The ceiling price of Spraberry crude oil last week was raised 7 cents to $2.65 per barrel for 40°-gravity and above.

The increase granted by the Office of Price Stabilization gives Spraberry production the same price as Mid-Continent and North Texas crude. The Spraberry ceiling had been frozen at $2.58 per barrel since January 1951. It had been pegged lower than nearby production because its price had been lower between December 19, 1950, and January 25, 1951, the period used in fixing ceilings.

The lower price at that time was due to the fact that the Spraberry development was new and transportation facilities were not fully developed in the area.

Spraberry Production Sold

MIDLAND. — Southern Production Co. has bought the interest of El Capitan Oil Co. in 2,200 acres in the Spraberry area of Upton, Midland, Reagan, and Glasscock counties, Texas. Price was $1,450,000.

Southern Production acquired about a one-third interest in the acreage, which contains 15 wells with a current production in excess of 400 bbl. daily and about 40 locations for additional wells.

Cree-Sykes Production Sold

BALLINGER, Tex.—Producing properties of Earl Wells in Cree-Sykes field of Runnels County have been purchased by Southern California Petroleum Corp. and Mohawk Petroleum Corp.

Purchase price was slightly in excess of $2,000,000 cash. Involved were leases on 940 acres and 11 flowing wells with a current allowable of about 1,100 bbl. daily. The leases also contain an estimated 12 undrilled locations, of which six might prove to be dual-zone completions.

Proven reserves are estimated at more than 4,000,000 bbl. by primary production.

Texas Tax Ruling Issued

AUSTIN.—Price Daniel, Texas attorney general, said here last week that liquid hydrocarbons recovered from natural gas by separators or other nonmechanical means are subject to the same tax rate as crude oil.

This means that these liquids are taxed at 4.6 cents per barrel when value is less than $1 per barrel or 4.6 per cent of the value when it is over this sum. Most companies have been paying a 4.125 per cent rate, the schedule existing before the state legislature rewrote the tax law last year.

Daniel's ruling on the tax rate was made in answer to a query by R. S. Calvert, state controller, who said a large number of taxpayers had taken exception to the higher rate.

The difference between the old and new rates is estimated to mean about $125,000 a year in state tax collections.

Fort Chadbourne Plant Set

DALLAS. — Lone Star Producing Co. will begin construction immediately of a natural-gasoline plant to process casinghead gas from Fort Chadbourne field in West Texas.

Cost of the project was estimated at $3,000,000. Location will be approximately 10 miles northeast of Bronte and 10 miles west of Winters.

Fort Chadbourne field is situated in the extreme northwest section of Runnels County and northeast Coke County. It contains approximately 250 oil wells operated by 11 producing companies and has been shut in since February 1 by order of the Texas Railroad Commission as a measure of preventing gas waste by flaring.

Lone Star's plant will have capacity to process 30,000,000 cu. ft. of casinghead gas per day and will produce natural gasoline, propane, and butane. Facilities will also be provided to use residue gas for repressuring.

More than 22 miles of 2 to 16-in. pipe will be laid initially to gather gas from the first-stage separators serving the producing wells in the field. In the near future a gathering system will be required to handle gas from the second-stage separators serving these wells, the company said.

HORTON*

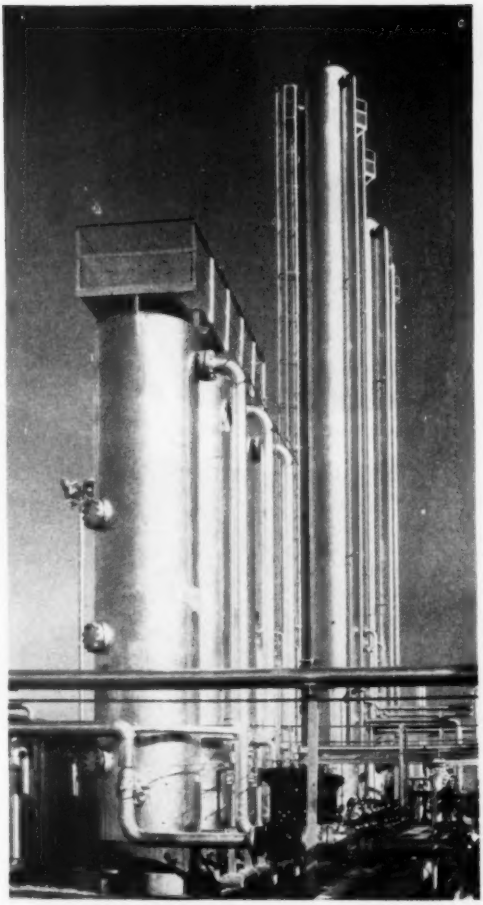
TANKS AND REFINERY TOWERS BUILT FOR GASOLINE PLANT IN NEW MEXICO

The recovery of valuable petroleum products has recently been increased at the Gulf Oil Corporation's Eunice, New Mexico, gasoline plant. Daily production is now approximately 950 barrels of 20-lb. Reid vapor pressure natural gasoline, 750 barrels of butane, and 1600 barrels of propane.

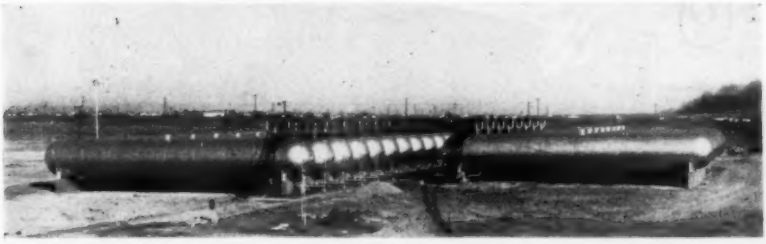
Playing an important part in the operation of the Eunice gasoline plant are a group of Horton* structures which were built to the specifications drawn up by the Hudson Engineering Corporation. Among the processing units we furnished are a propanizer tower, a depropanizer tower, three dehydrators, and two absorber columns. Horton storage facilities consist of eight propane tanks, six butane tanks, and six natural gasoline tanks—all cylindrical in shape with hemispherical ends.

Throughout the petroleum, petrochemical and chemical industries, Horton structures are playing a vital part in increasing production and attaining new and higher operating efficiencies. For more complete information, estimates or quotations on steel or corrosion-resistant metal storage tanks and processing equipment, write our nearest office. There is no obligation on your part.

**Registered U. S. Patent Office.*



Three 4½-ft. diam. by 24-ft. gas dehydrators built by Chicago Bridge & Iron Company for the Gulf Oil Corporation's Eunice, N. M., gasoline plant.



Twenty 1,000-bbl. cylindrical tanks with hemispherical ends used to store propane, butane and natural gasoline at the Eunice gasoline plant.

CHICAGO BRIDGE & IRON COMPANY

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNSYLVANIA

Atlanta, 3.....2154 Healey Bldg.
Birmingham, 1.....1536 North 50th St.
Boston, 10.....1025—201 Devonshire St.
Chicago, 4.....2128 McCormick Bldg.
Cleveland, 15.....2204 Guildhall Bldg.
Detroit, 26.....1514 Lafayette Bldg.
Havana.....402 Abreu Bldg.
Houston, 2.....2119 C & I Life Bldg.
Los Angeles, 17.....1523 General Petroleum Bldg.
New York, 6.....3347—165 Broadway Bldg.
Philadelphia, 3.....1615—1700 Walnut Street Bldg.
San Francisco, 4.....1544—200 Bush St.
Seattle, 1.....1325 Henry Bldg.
Tulsa, 3.....1606 Hunt Bldg.
Washington 6, D. C.....1139 Cafritz Bldg.

REPRESENTATIVES AND LICENSEES

Horton Steel Works, Limited, Fort Erie, Ontario, Canada
Ateliers et Chantiers de la Seine Maritime, Paris, France
Constructions Metalliques de Provence, Arles-sur-Rhone, France
Chicago Bridge & Iron Company, Ltd., Apartado 1348, Caracas, Venezuela
Comprimo N.V., Amsterdam—O, Netherlands
Compagnia Tecnica Industrie Petroli, Rome, Italy
Whessoe, Limited, Darlington, England
M-therwell Bridge & Engineering Company, Limited, Motherwell, Scotland
Sociedado Chibridge de Construcoes Ltda., Av. Franklin Roosevelt, 194-S/704-C, Rio de Janeiro, Brazil

Steel's "Blood Bank" needs your help

In normal times, steel's winter "blood bank" of iron and steel scrap is built up during the fall. But not this year. Hungry steel mill furnaces are still on a hand-to-mouth diet of scrap—and may stay that way for a long time.

Because scrap is the *lifeblood* of today's high steel production, your help in getting in the scrap is desperately needed.

This is why: The steel industry is growing much faster than the supply of scrap. With steel capacity now rated over 100 million tons a year, about 37 million tons of purchased scrap will be needed each year.

Unless idle scrap is turned in there is danger that steel production may be cut in the months to come.

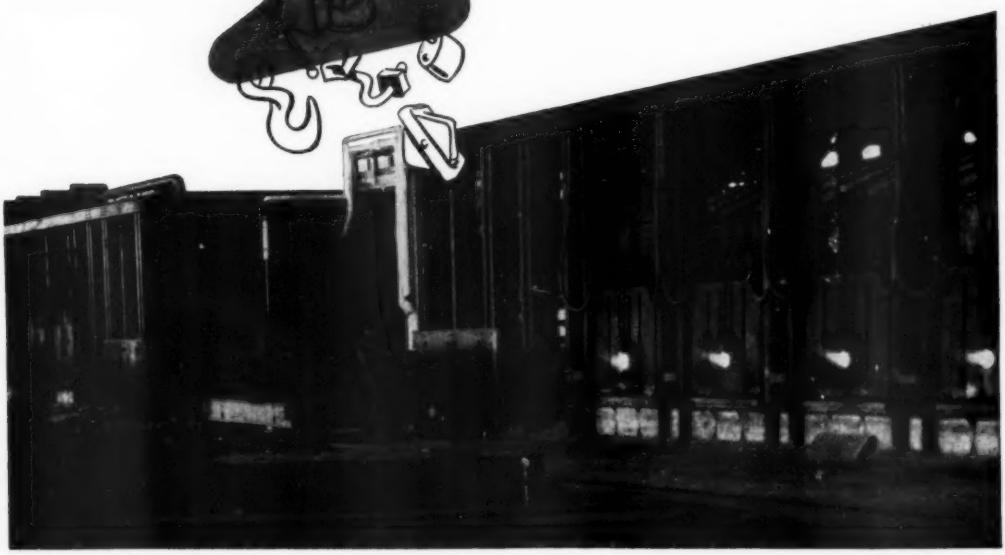
Pays in Cash Too

The price of scrap is another good reason for you to help. You get a good cash return for your iron and steel scrap by selling now and also help assure steel for vital equipment.

So take these two simple steps: Survey your plant and storage yards for worn-out iron and steel parts and equipment; then call your scrap dealer. But don't stop here. Make plans now to establish a regular scrap collection program.

ARMCO DRAINAGE & METAL PRODUCTS, INC.

1992 CURTIS STREET, MIDDLETOWN, OHIO
PLANTS AND SALES OFFICES FROM COAST TO COAST
EXPORT: THE ARMCO INTERNATIONAL CORPORATION



Projects Approved

DPA approves accelerated amortization for 42 petroleum industry projects with a total investment of $115,116,000

WASHINGTON. — Certificates of necessity for accelerated amortization of 42 petroleum projects with a total investment of $115,116,000 were issued by the Defense Production Administration during the first half of February.

The largest of 636 projects approved by DPA was a $44,550,000 investment by The Texas Co. in facilities for high-viscosity lubricating oils at Lockport, Ill., on which it was given accelerated amortization on 65 per cent of $17,622,000, 50 per cent of $10,774,000, and 15 per cent of $1,200,000.

The eighth largest in the list was a $22,340,700 investment, also by Texaco, in transportation facilities, of which 60 per cent was given quick write-off.

The certificates granted for oil broke down into 10 for refining projects, to cost $57,658,057; 7 for pipe lines, to cost $26,019,897; 4 for transportation facilities, to cost $23,008,975; and 21 for storage facilities, to cost $8,431,495.

Refining.—The refining projects, in addition to the Texaco plant, included $3,101,500 for bead-catalyst facilities by Socony-Vacuum Oil Co., Inc., at Paulsboro, N. J., granted accelerated amortization on 75 per cent; $195,792 for aviation fuel antioxidant by the Koppers Co. at Oil City, Pa., 50 per cent; $1,770,000 for gasoline facilities by Ashland Oil & Refining Co. at Findlay, Ohio, 65 per cent of $1,110,000 and 45 per cent of $185,000; $172,650 for detergent-type additives by Standard Oil Co. (Ind.) at Wood River, Ill., 65 per cent on $116,500 and 45 per cent on $56,100.

A total of $145,000 for butadiene and butylenes by Jefferson Chemical Co. at Port Neches, Tex., 90 per cent; $414,146 for butanes, natural gasoline, and propane by The California Co. at Rangely, Colo., 65 per cent; $1,760,000 for cumene for production of phenol by Salt Lake Refining Co. at Salt Lake City, Utah, 50 per cent of $1,358,000 and 40 per cent of $402,000; $208,969 for petroleum polymer resins by Neville Co. at Anaheim, Calif., 45 per cent of $73,450; and $5,340,000 for phenol by Standard Oil Co. of California at San Francisco, 50 per cent of $4,605,000, 45 per cent of $723,000, and 15 per cent of $12,000.

Pipe lines.—The pipe-line projects included investments of $6,363,000 by Gulf Refining Co., 25 per cent on $6,358,100; $200,000 by Miami Valley Corp., 25 per cent; $169,301 by Roosevelt Oil & Refining Corp., 25 per cent; $14,262,200 by Standard Oil Co. (Ind.), 25 per cent of $14,187,400; $2,928,396 by Bell Oil & Gas Co., 25 per cent of $2,865,076; $162,000 by Phillips Pipe Line Co., 25 per cent; and $1,935,000 by Continental Pipe Line Co., 15 per cent of $967,250.

The transportation projects, in addition to that of The Texas Co., were Tanker Hygrade No. 2, Inc., New York, $325,000, 70 per cent; Ernest T. Schoenwald, East Cleveland, Ohio, $148,275, 70 per cent; and Warren Petroleum Corp., Tulsa, $195,000, 70 per cent.

Storage.—Certificates for storage covered the following projects: Shell Oil Co. at South Portland, Me., $128,000, 40 per cent; Gulf Oil Corp. at Providence, R. I., $295,660, 40 per cent of $274,660; Atlantic Refining Co. at Revere, Mass., $352,780, 40 per cent; Gulf Oil Corp. at Burlington, Vt., $101,200, 40 per cent of $99,000.

Shell Oil Co. at Rensselaer, N. Y., $120,540, 40 per cent; Sinclair Refining Co. at Tremley Point, N. J., $270,000, 40 per cent; Public Service Oil Co. at Bronx, N. Y., $136,478, 40 per cent; Ashland Oil & Refining Co. at Florette, Pa., $224,300, 40 per cent; Gulf Oil Corp. at Pittsburgh, $1,326,737, 40 per cent of $1,306,827; and Shell Oil Co. at Wilmington, N. C., $112,500, 40 per cent.

The Texas Co. at Cincinnati, $117,000, 40 per cent; Newton Oil Co. at Hichman, Ky., $65,000, 40 per cent of $56,500; Sinclair Refining Co. at Milwaukee, $904,300, 40 per cent of $744,500; General American Transportation Corp. at Argo, Ill., $856,700, 40 per cent.

Shell Oil Co. at Lionsville, Ind., $132,000, 40 per cent; Shell Oil Co. at Argo, Ill., $673,800, 40 per cent; Shell Oil Co. at St. Paul, Minn., $137,000, 40 per cent; Shell Oil Co. at Bettendorf, Iowa, $130,000, 40 per cent; Phillips Pipe Line Co. at Bartlesville, Okla., $1,161,000, 40 per cent of $1,059,750; and Shell Oil Co. at Seattle, $491,000, 40 per cent.

NPA Revamps Orders

WASHINGTON.—The following orders have been issued by the National Production Authority:

Amendment to M-80, March 12: Revising the procedure for handling allocations of nickel, anodes, salts, chemicals, oxides, and catalysts.

Amendment to M-25, March 13: Permitting canners and packers to use secondary tin-mill plate without having it charged against quotas.

Amendment to M-19, March 13: Relaxing use controls on cadmium.

Revocation of M-68, March 14: Eliminating controls on production of passenger automobiles and placing them under the Controlled Materials Plan.

Tube-Goods Rule

Nonworking stocks not to be counted on inventory

WASHINGTON. — Calculations of tubular-goods inventories of oil and gas operators applying to the Petroleum Administration for Defense for priorities assistance will be revised under certain circumstances to eliminate inclusion of "nonworking" stocks.

Heretofore, operators submitting the 90-day working inventory have been required to list all their unused materials. These might include some pipe purchased for a special operation in the past which is not reasonably usable in a current drilling program, or fragmentary items of no general and immediate use.

"Since inventory is considered in the calculation of allotments of tubular goods to which an operator is entitled, the inclusion of such stocks in total tonnage of inventory calculations could result in denying to the operator a working supply suitable for his needs during the quarter," Deputy Administrator Bruce K. Brown pointed out in announcing the change.

"Under the new system an operator will be able to have the nonworking items deducted from his total inventory. He will then be charged only with the usable materials he has available."

Must be listed.—In order to avail himself of this consideration, an operator is still required to include these items in his inventory statement on Form PAD-16 and to list the nonworking stock separately, showing tonnage, size, weight, grade, specification, and location.

He must also file a letter with PAD in which he agrees to effect trades of such pipe when feasible; make it available for sale to an operator who has an immediate use for it and an appropriate authorization; and to obtain permission from PAD before using such pipe in his own operations.

A typical letter embodying this agreement has been prepared and may be obtained from the PAD production division in Washington.

Materials Aid

PAD to help in placing orders, speeding delivery

WASHINGTON. — Recent reorganization of the materials division will make it possible for the Petroleum Administration for Defense to give increased assistance to oil and gas operators in placing orders for controlled materials and in speeding their delivery.

A system has been set up whereby any operator who wants PAD assistance in placing an authorized order for controlled materials or in getting delivery faster than promised by a manufacturer may call directly upon the agency for help. This can be done either by letter or on a form, NPAF-148, available from National Production Authority offices.

Information needed. — Separate requests should be made for steel, copper, and aluminum, and information furnished must include:

1. The date and PAD file number of the operator's authorization. If the operator is attempting to purchase oil-country tubular goods, he should state whether he is getting the pipe from set-aside stocks or by direct mill shipment on a regular grant. He must also show the size, grade, and tonnage of casing and tubing required.

2. Names of suppliers who have furnished the major part of the applicant's requirements for previous operations.

3. Names and locations of suppliers with whom the applicant has tried to place the order on which he is asking assistance and the response he got from each. If the order has been rejected, the applicant should get a written statement from the supplier of the rejection and the reason for it and attach it to the request for aid.

If an order has been placed and the operator is asking only for help in getting shipment, he should give the name of the supplier and the delivery schedule he has established.

Review of requests.—Upon receipt in PAD, requests will be reviewed by the appropriate operating division to determine their urgency and justification, and recommendation whether action should be taken will be made to the materials division. Where it is determined that assistance should be given, the materials division may advise the operator directly of what action he can take or may enlist the support of the metals and minerals bureau of NPA in the placing of the orders or the speeding up of delivery.

The procedure is designed to take some of the difficulty out of the placing of priorities-assistance tickets, but officials warned that there can be no guarantee that all difficulties will be eliminated so long as materials continue in short supply.

WATCHING WASHINGTON

Bertram F. Linz

Price Struggle

A tough fight over price control is developing on both sides of the Capitol. While there seems to be little chance of Congress ordering the Office of Price Stabilization to revoke its regulations on commodities selling below ceiling prices, there is a good possibility a provision requiring suspension of controls in such cases may be inserted into the new Defense Production Act.

Such a provision would not do anything for oil, however, and an effort is being made to enlist congressmen from the producing states behind legislation that would approach this problem from a different angle.

Decontrol of crude prices would be attained under a bill introduced by Rep. Omar Burleson of Texas. The bill would set up standards for mandatory decontrol under which OPS would be required to revoke its regulations with respect to materials not susceptible to speculative buying and where not more than 10 per cent of the total national production of the material is purchased for defense purposes when such materials go below ceiling prices or are in ample supply to meet current demands over a period of 6 months. A material would be considered in adequate or surplus supply whenever it is not being allocated for civilian use.

Since crude oil would meet three of these four requirements, it would immediately qualify for decontrol. On the other hand, suspension of controls based on a long period of below-ceiling prices would not benefit oil since, unlike other commodities, crude prices have not risen as a result of the Korean fighting and, because of increased costs, cannot fall off.

Barges vs. Railroads

The nation's railroads, engaged for years in a running fight with the highway truckers, have taken on a new opponent, the inland barge operators, and the waterways people are hitting back.

The issue in the fight is a bill introduced in Congress to levy tolls on the inland waterways, a move which the barge and towing interests charge would affect the economy of important sections of the country by increasing fuel and raw-material costs.

Figures developed by the Petroleum Administration for Defense for its recently-issued transportation report include an estimate that in 1950 the average daily volume of oil handled by the inland waterways was 2,465,500 bbl., or 17.9 per cent of the oil moved by all carriers. Not all of this volume would be affected by the toll legislation, since the measure would exempt the Great Lakes from levy.

The barge and towing interests charge the railroads with a "sneak attack" designed to lay the groundwork for heavy freight-rate increases and assert the bill is discriminatory because it exempts the Great Lakes and seaports where the railroads operate their own vessels, although inland waters and coastal harbors are both improved and maintained out of the same federal funds.

More Steel Coming

Third-quarter steel allocations for the oil and gas industry probably will be greater than second-quarter allotments but less than requested by the Petroleum Administration for Defense.

The Defense Production Administration reportedly has decided that the industry's 18-month expansion program is a step in the right direction and will approve at least a substantial start on it. An announcement to this effect is expected in the near future, and the third-quarter allocations may make provision for it.

Third-quarter needs of the industry were figured by PAD at approximately 2,300,000 tons, of which some 1,750,000 would be for oil operations and 550,000 for gas. This would be an increase of more than 400,000 tons for oil operations over the allotment for the coming quarter.

Final decision on the allocation is not expected to be reached by the DPA until the second week in April, but current reports are that it will be at least 80 per cent of the amount requested by PAD. That would give the industry something in the neighborhood of 1,840,000 tons, an increase in the range of 130,000 tons.

If producers find themselves able to use mechanical tubing, however, the over-all supply of tubular goods may be considerably more than the 412,000 tons of carbon and 38,000 tons of alloy steel allocated for that purpose for the second quarter.

THE BIG PULL'S OVER. It won't be long now before drilling operations are under way.

Big Pull for New Oil

Frank Connors' International TD-14A pulls 63,000-pound drilling rig up on foundation

International power makes oil field preparation a whole lot simpler for Frank Connors, Magnolia, Arkansas.

He uses a fleet of five International TD-14A crawlers for all kinds of jobs—from pulling four times their weight in drilling rigs to digging the slush pits alongside.

As you see in the picture above, one of the TD-14As used its winch to pull this 63,000-pound drilling rig up on its platform foundation, after unloading, aligning and straightening the foundation itself. Then it dug two slush pits—and got the whole "rigging up" job done in twenty-four hours.

Get the whole story on what International power can do on your oil field jobs from your International Industrial Distributor. All through the oil fields, it's International *"Power that Pays."*

INTERNATIONAL HARVESTER COMPANY, CHICAGO 1, ILLINOIS

INTERNATIONAL HARVESTER

INTERNATIONAL

POWER THAT PAYS

DIGGING THE SLUSH PIT. Main pit is six feet deep, twenty yards long. Reserve pit is 25 yards in diameter.

Maintenance Cost Protested

WASHINGTON. — Complaints of civil-airline operators against PAD Order No. 4, requiring the use of at least 4 cc. of tetraethyl lead per gallon of 100-octane aviation gasoline, appear to be based more on the increased maintenance burden involved than in any inherent danger in the gasoline itself.

This is indicated by information given the House Interstate Commerce Committee by the Petroleum Administration for Defense.

The House committee has been investigating the effects of the order in connection with its inquiry into the causes of plane crashes at Elizabeth, N. J. PAD officials declared that neither the Civil Aeronautics Board nor the military have ever been able to trace a plane crash to the fuel used.

As a matter of fact, the committee was informed, all planes, military and commercial, used fuel containing 4.6 cc. of TEL per gallon during World War II, and the same types of engines then employed are still used in Lockheed Constellations, DC-3s, DC-4s, and DC-6s. Since the end of the war, all military aircraft have continued to use gasoline containing 4.6 cc. of TEL.

Four of the five major domestic air lines, prior to issuance of Order No. 4 last year, got 50 per cent or more of their gasoline with 4 cc. of tetraethyl lead.

All 100-octane gasoline with which planes were serviced at the National Airport at Washington from the time it was opened during the war until the end of 1950 contained 4 cc. of TEL or more. When the supply contract at the airport was split, one of the two suppliers sold gasoline containing 3 cc. of TEL, but it went into the same central storage system along with the 4-cc. gasoline provided by the other supplier.

Washington Briefs

The Federal Maritime Board reports 53 tankers are among the 111 vessels under construction or contract in private American shipyards. As of March 1, the active fleet of 2,027 vessels in the merchant marine included 451 privately owned tankers and 3 small coastal tankers owned by the Government and used by the Navy.

The Bureau of Land Management will open bids April 30 for oil and gas leases on two parcels of land in De Soto field, 6 miles east of Mansfield, La. The land will be offered in parcels of 79.6 and 80.02 acres to the qualified bidder of the highest cash bonus on the usual rental and royalty terms.

Howard B. Noyes, vice president of Washington Gas Light Co., will take over next week as assistant deputy petroleum administrator in charge of gas-transmission and distributing operations. He will succeed C. P. Rather, who is leaving the Petroleum Administration for Defense March 31 to return to his position as president of Southern Natural Gas Co.

ECONOMICS

Imports Gain

January receipts of crude, products near all-time high

TOTAL imports of crude and products in January were exceeded only by the all-time record established in January 1951, according to data released by the Census Bureau of the Department of Commerce.

Imports averaged 976,000 bbl. daily, an increase of 22.6 per cent over December but 2.9 per cent less than the record for January 1951.

Crude imports for the month were at the rate of 513,000 bbl. daily compared with 386,000 bbl. daily in December and 522,000 bbl. daily in January of last year.

The record month for crude imports was July 1951 when the average was 568,000 bbl. daily.

Except for a decline in receipts from Mexico, crude imports in January were larger than December for each country normally shipping crude to the United States.

Venezuelan receipts. — The greatest increase was in receipts from Venezuela, 329,700 bbl. daily in January compared with 268,100 bbl. daily in December.

The loss of Iranian production to world markets caused a decrease in shipments of crude from Saudi Arabia to this country from 77,500 bbl. daily last July to 6,800 bbl. daily in November and no shipments at all in December. January imports from Saudi Arabia were back up to 30,100 bbl. daily.

IMPORTS INTO CONTINENTAL UNITED STATES
(Thousands of barrels)

	Jan. 1952	Dec. 1951	Jan. 1951
Crude—			
Mexico	1,022	1,268	1,125
Colombia	1,616	819	1,568
Venezuela	10,220	8,311	9,252
Kuwait	1,570	1,172	2,274
Saudi Arabia	932		1,760
Borneo	448	325	213
Canada	101	58	
Total crude	15,909	11,953	16,192
Daily average	513	386	522
Products—			
Residual fuel	12,938	12,040	13,842
Other products	1,405	683	1,117
Total products	14,343	12,723	14,959
Daily average	463	410	483
Total all oils	30,252	24,676	31,151
Daily average	976	796	1,005

EXPORTS*
(Thousands of barrels)

	Jan. 1952	Dec. 1951	Jan. 1951
Crude	2,303	2,147	2,913
Gasoline	2,552	3,442	1,125
Kerosine	750	385	46
Distillate fuel	1,870	1,821	660
Residual fuel	1,830	2,006	663
Lube oils	1,759	1,430	1,163
Other products	746	751	447
Total all oils	11,810	11,982	7,017
Daily average	381	387	226

*Excludes shipments to territories.

Products imports averaged 463,000 bbl. daily in January compared with 410,000 bbl. daily in December and 483,000 bbl. daily in January 1951. Residual imports climbed back to 417,400 bbl. daily in January after a 6-month period of low-level receipts brought about by the closing of the Abadan refinery.

Exports down. — Total exports, excluding shipments to territories, averaged 381,000 bbl. daily, a decrease of 6,000 bbl. daily from December. Decreases for gasoline and residual were almost balanced by increases for crude, kerosine, distillate, and lube oils. The peak for 1951 was reached in August with an average of 523,100 bbl. daily.

Import Quota Filling Fast

WASHINGTON.—More than 40 per cent of the 1952 quota of foreign oil to be permitted importation at the 10½ cents per barrel tax rate of the Venezuelan trade agreement entered the United States in the first 2 months of the year, according to figures just released by the Treasury Department.

The 1952 quota is 4,977,848,400 gal. and imports up to March 1 were 2,112,111,164 gal., the department reported.

A breakdown of the import statistics showed that 959,338,916 gal. were imported against Venezuela's quota of 2,956,841,949 gal., 615,900,103 gal. out of the 930,857,651 gal. assigned to the Netherlands, and 536,872,144 gal. against the quota of 1,090,148,000 gal. for all other countries.

Exports of Products Down

WASHINGTON.—Exports of major petroleum products dropped to the low level of 127,300 bbl. per day for the week ended February 22, according to preliminary figures released by the Petroleum Administration for Defense.

The figures, however, are tentative and subject to revision, a process which brought the export total for the preceding week up from 166,300 to 213,000 bbl. daily.

The initial report for the week ended February 22 showed that kerosine exports were at the highest level since the week ended January 18, while shipments of all other products

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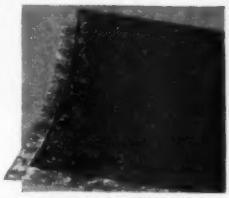

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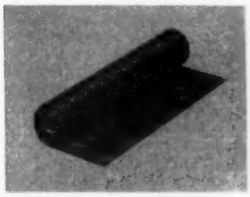

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were substantially below those of the week ended February 15.

Average daily exports of the several products, compared with the preceding week and with the average for 4 weeks ended February 22, in thousands of barrels, were as follows:

	Feb. 22	Feb. 15	4 Weeks ended Feb. 22
Aviation gasoline	2.9	34.3*	32.3
Motor gasoline	17.8	28.0	17.6
Kerosine	18.3	4.9	5.8
Distillate	31.6	75.9*	51.5
Residual	56.7	69.9	62.9
Total	127.3	213.0*	170.1

*Revised

WEST COAST

Price Rise Supported

Californians join I.P.A.A. in seeking price increase

LOS ANGELES.—The drive to decontrol crude-oil and natural-gas prices started earlier this month by the Independent Petroleum Association of America is being echoed by West Coast independent producers.

Currently the crude-price situation, and particularly that of heavy crudes, is being studied by committees of the Oil Producers Agency of California and the San Joaquin Valley Oil Producers Association.

No action has as yet been taken but it is anticipated they shortly will at least seek an adjustment in low-gravity-crude prices, which are 35 cents per barrel below 1948 levels.

What probably constituted the opening gun was contained in a recent bulletin of the Oil Producers Agency. Speaking of heavy fuels, the report stated, "Since heavy-crude prices are disproportionately low in comparison with light-crude prices, and in fact are lower than they were in 1948, a question as to the adequacy of those prices immediately arises."

Stocks down.—It was further pointed out that because at no time last year was the supply of petroleum adequate to meet demands in District 5, total stocks of crude and refined products at the end of February were only some 82,000,000 bbl., down 15,220,000 bbl. from those of a year ago.

These decreases occurred principally in distillates and fuel-oil stocks. The former were estimated to total 7,700,000 bbl. on February 29, a drop of about 2,800,000 bbl. as compared with a year ago. It was registered despite higher refinery throughput supplying increased distillate production of 8,000 bbl. daily.

Stocks of residual fuels were estimated at approximately 10,800,000 bbl. at the end of February, or about 6,800,000 bbl. below those at the end of February 1951. Production of these fuels, it was brought out, totaled 374,000 bbl. daily last year, up 44,000 bbl. daily over 1950 levels.

Production increased.—The decrease in total stocks was registered despite the state's crude production being increased 73,000 bbl. to a yearly average of 971,000 bbl. daily.

Total supply of all petroleum last year, which includes receipts of crude and products from sources outside District 5, and production of natural gas liquids, averaged 1,089,000 bbl. daily.

Total demand averaged 1,126,000 bbl., or an average withdrawal from stocks of 37,000 bbl. daily during the year.

Injection Plan Revised

LONG BEACH.—A revised proposal by Long Beach Oil Development Co. for an experimental gas-injection program in the Terminal Island area of Wilmington field has been submitted to the Harbor Commission.

To study the effects of such a program, a pilot-plant operation involving injection of 6,000 M.c.f. of gas daily has been approved by the commission. If the operation proves feasible the commission then plans to install a $1,500,000 plant capable of returning 20,000 M.c.f. daily.

L.B.O.D., contractor for the city-owned properties where the project is planned, does not want the program to proceed if it would cause oil to migrate beyond its leases, or if it materially affects current oil withdrawal rates.

Accordingly the company is seeking to incorporate in the plan provisions which will limit to 25 per cent the number of wells which may be shut in, and provide for halting the program if it materially affects oil production in areas outside its operating jurisdiction.

ROCKY MOUNTAIN

80-Acre Spacing Denied

BISMARCK, N. D.—North Dakota's Industrial Commission has ordered 40-acre minimum well spacing for Beaver Lodge Madison pool in Williams County.

The commission denied by a 2-to-1 vote the petition of Amerada Petroleum Corp. for a minimum 80-acre-spacing rule. Gov. Norman Brunsdahl, commission chairman, voted for 80-acre spacing.

Brunsdahl said he favored 80-acre spacing "tentatively," feeling that sufficient wells had not been drilled to indicate proper spacing and that Amerada should be able, at least for the present, to develop the area as it wished.

Atty. Gen. Elmo Christianson and Commissioner of Labor and Agriculture H. L. Dahl voted for 40-acre spacing, contending that Amerada had not proved conclusively that 80-acre spacing would provide adequate drainage.

New Products Line Planned

SALT LAKE CITY.—Salt Lake Pipe Line Co., a subsidiary of Standard Oil Co. of California, will build a 330-mile products pipe line from Salt Lake City to Boise, Idaho.

The line will cost $8,000,000 and will parallel an existing pipe line completed to Boise 2 years ago, and then extended to Pasco, Wash.

Completion of the new line will boost the company's transportation capacity along this route from 22,000 bbl. to 39,500 bbl. daily. With addition of supplementary pumping stations, it would be possible to raise capacity to 45,000 bbl. daily.

Decision to build the new petroleum-products line was announced by T. S. Petersen, president of California Standard, and C. E. Finney, Jr., president of Salt Lake Pipe Line Co.

Work on the project is expected to get under way within a few months, if pipe is made available. It is hoped that it can be completed by late 1952.

The new 8-in. line will tie into existing take-off points along its route in southern Idaho.

Additional tankage of about 200,000-bbl. capacity will be built at the line's Boise terminal to handle the increased flow of oil.

MID-CONTINENT

Old Field in Fortieth Year

CUSHING, Okla.—Oklahoma's Cushing field, credited with making several hundred millionaires and furnishing the incentive for the launching of 100 active oil companies, observed its fortieth anniversary last week.

The old field in western Creek County, now making 7,250 bbl. a day, showed its first oil March 17, 1912. Production since then has been estimated at about 400,000,000 bbl. of high-gravity oil.

The discovery well, on a lease owned by Deep Rock Oil Corp., was Shaffer & Smathers, Inc., 1 Wheeler (nee Jones) about 12 miles east of Cushing. History has it that three men figured prominently in the strike and subsequent early development in the field.

One of these was C. B. Shaffer of Shaffer & Smathers, Inc., Chicago, who played a hunch that oil existed under the Oklahoma soil southwest of Tulsa. He started sinking holes at 4-mile intervals beginning west of Sapulpa and covering 30 miles in a westerly direction before the discovery.

World Crude Production

Little change noted in January, but total output was almost 600,000 bbl. daily over that of January 1951

Dahl M. Duff

WORLD production of crude oil in January showed little change from the previous month but the total output was nearly 600,000 bbl. daily over January 1951.

Production world-wide, including estimated output of Russia and its eastern Europe satellites, averaged 11,874,400 bbl. daily. The gain over December was only 27,900 bbl. daily. United States production was up an estimated 10,800 bbl. daily, and foreign areas, 17,100 bbl. daily.

This virtually negligible increase from December to January compares with the sharp drop of 260,000 bbl. daily from November to December. In November, world production rose to an all-time high of 12,007,000 bbl. daily but declined to 11,846,500 bbl. daily the following month.

Taking out production attributed to Russia and eastern Europe, the world total in January of this year was 10,843,200 bbl. daily. This total for the western world was 467,200 bbl. daily over that in January 1951. The increase amounts to 4.5 per cent—somewhat less than anticipated. However, demand trends are difficult to assess from month-to-month figures which fluctuate considerably with storage changes, transportation, and other conditions.

There is considerably more crude production capacity available than was used in January. The two major Middle East producers, Saudi Arabia and Kuwait, are below previous highs and their indicated potential with present facilities. More capacity also is available in the United States. Elsewhere, however, in Venezuela, Indonesia, and Iraq, output appears to be virtually at maximum levels.

Canada.—Canadian production in January dropped back about 2,000 bbl. daily. Any large increases in output from Alberta awaits the opening of shipping on the Great Lakes. Beyond this, further pipe-line capacity will be provided by the construction of the planned line to the Pacific Northwest.

Colombia.—Colombian production was back at about 107,000 bbl. daily after declines the two previous months. The total, with condensate, was 109,696 bbl. daily.

Venezuela.—Another new all-time record was set by Venezuelan crude production in January. The month's daily average represented an increase of approximately 35,000 bbl. daily over December. In only one of the last 13 months has production in Venezuela failed to increase over the

WORLD CRUDE-OIL PRODUCTION
(In thousands of barrels daily)

Country—	Jan. 1952	Dec. 1951	Jan. 1951
Western Hemisphere:			
Argentina	70.0	70.0	64.8
Bolivia	1.5	1.6	1.6
Brazil	1.4	1.5	1.3
Canada	124.4	126.5	94.9
Chile	2.2	2.1	1.8
Colombia	107.4	101.2	101.3
Cuba	0.1	0.1	0.3
Ecuador	7.7	7.8	7.0
Mexico	206.0	215.1	217.2
Peru	45.5	45.4	42.4
Trinidad	57.5	57.2	57.5
Venezuela	1,811.7	1,776.4	1,634.4
Total	2,435.4	2,404.9	2,224.5
Europe and Africa:			
France	6.5	6.4	4.2
French Morocco	1.9	1.9	1.0
Germany	29.1	28.8	23.2
Italy	0.5	0.5	0.1
Netherlands	12.0	11.7	12.3
Egypt	45.5	45.8	46.0
United Kingdom	1.0	1.1	0.9
Total	96.5	96.2	87.7
Middle East:			
Bahrein	30.1	30.2	30.1
Iran	30.0	38.0	647.8
Iraq	187.0	192.4	168.6
Kuwait	674.1	673.0	422.0
Qatar	57.3	58.5	44.1
Saudi Arabia	853.7	853.8	561.2
Turkey	0.4	0.4	0.3
Total	1,832.6	1,846.3	1,874.1
Other Asia:			
British Borneo	103.0	102.5	102.6
Burma	2.0	2.0	2.0
China	2.2	2.2	2.2
India	5.0	5.0	5.2
Indonesia	160.0	160.0	156.7
Japan	5.7	5.8	5.8
New Guinea	4.8	4.9	4.8
Pakistan	3.0	3.3	3.6
Total	285.7	285.7	282.9
Total foreign less Russia and E. Europe	4,650.2	4,633.1	4,469.2
Estimated Russia and Eastern Europe:			
Austria	43.0	43.0	32.0
Romania	95.0	95.0	85.0
Russia	860.0	860.0	775.0
Other E. Europe	33.2	33.2	24.1
Total	1,031.2	1,031.2	916.1
Total foreign	5,681.4	5,664.3	5,385.3
United States	6,193.0	6,182.2	5,906.8
World total	11,874.4	11,846.5	11,292.1

Figures are from reliable reports in the industry or official government sources. Data for Russia and eastern Europe are based on competent estimates; no authentic information is available on month-to-month production in these areas. Completely current reports also are lacking for certain countries of Southeast Asia. Data for earlier months have been revised where necessary.

VENEZUELAN PRODUCTION

(Government figures for January in barrels daily)

Creole	814,073
Shell	571,659
Mene Grande	258,647
Socony-Vacuum	52,703
Texas	22,495
Mercedes	24,216
Atlantic	17,536
Richmond	15,833
Sinclair	14,063
Phillips	10,615
Pantepec	8,513
B.C.O.	940

previous month. The January production marked the first time that output has risen above the 1,800,000-bbl. daily mark.

Production by weeks in Venezuela in January was: Week ended January 7, 1,797,500 bbl. daily; January 14, 1,811,100 bbl. daily; January 21, 1,820,600 bbl. daily; and January 28, 1,807,200 bbl. daily. The January 21 total was a new high on a week basis to that date.

Middle East.—In the Middle East, in January, neither Saudi Arabia nor Kuwait showed any production change of significance. The gain made by Iraq in the last 2 months was due to the opening in December of Zubair field by Basra Petroleum Co., Ltd. In January, Iraq's production consisted of 164,000 bbl. daily from Kirkuk, 14,800 bbl. daily from Zubair, and 8,200 bbl. daily from Khanaquin.

National Iranian Oil Co., which was placed in control of the nationalized properties of Anglo-Iranian Oil Co., Ltd., in southern Iran, disclosed crude production figures for the final 3 months of last year. In tons, these were: October, 17,849, November, 235,834; and December, 154,054.

The comparable figures in barrels daily are 4,400, 60,100, and 38,000 respectively. The higher November figure was due to the operation during most of that month of one of the large units of the Abadan refinery.

Some limited refinery operations are understood to be continuing at Abadan to replace products withdrawn for distribution on the domestic market. In addition, the Iranian company continues to operate the 2,500-bbl. daily Kermanshah refinery.

Europe.—Production of crude oil in western Germany during January amounted to 127,095 metric tons. This consisted of 54,563 tons from Emsland, 62,291 tons from Hanover, 9,732 tons from Schleswig-Holstein-Hamburg, and 509 tons from Baden.

Recent informed estimates credit Romania with a somewhat higher production than heretofore attributed to that country. Forced-production techniques are balanced against naturally declining fields and difficulties experienced by the Communists with technical manpower and equipment.

The exact production of Romania, as with the other Communist countries, is a closely guarded state secret. However, various sources believe the country is close to, if not exceeding, 100,000 bbl. daily.

TREND OVER THE LAST YEAR

	W. Hemisphere less U. S.	Middle East	Total foreign less Russia and E. Europe
1951—			
February	2,220.3	1,947.4	4,536.8
March	2,254.1	1,961.1	4,581.1
April	2,261.5	2,013.4	4,632.1
May	2,314.0	2,203.8	4,878.4
June	2,335.5	2,172.4	4,877.8
July	2,374.5	1,835.5	4,579.0
August	2,368.0	1,789.7	4,555.3
September	2,396.3	1,741.7	4,517.6
October	2,395.6	1,810.6	4,585.6
November	2,383.7	1,940.4	4,709.5
December	2,404.9	1,846.3	4,633.1
1952—			
January	2,435.4	1,832.6	4,650.2

Tanker Construction Doubled

World-wide tanker construction, including jobs on order, has doubled since January 1951, according to Shipbuilders Council of America, New York.

Although the United States ranks only fifth in tanker construction, the number of ships under construction or on order in this country has jumped from 6 to 37 in the past year, representing a total gross tonnage increase from 94,500 to 603,020. Great Britain remains the leader, followed by Sweden, Germany, and Holland.

New construction of merchant tankers in hand or on order for January 1952 are summarized below:

TANKERS BUILDING OR ON ORDER

January, 1952

Country	Number of Vessels	Gross Tonnage
Great Britain	272	3,403,243
Sweden	107	1,339,941
Germany	57	749,598
Holland	56	650,979
United States	37	603,020
Japan	25	378,500
Norway	37	339,786
France	11	191,095
Denmark	14	142,600
Belgium	9	108,737
Italy & Trieste	8	111,850
Canada	5	63,950
Spain	3	11,116
Totals	641	8,094,415

Two Big Tankers Ordered

Orders for two of the largest tankers yet contracted have been placed with Bethlehem Steel Co.'s shipbuilding division by the S. S. Niarchos interests.

The vessels will have a deadweight capacity of 45,400 tons and will be 700 ft. in length. It is expected they will be laid down in January of next year and completed in about 12 months' time.

The largest tankers ordered previously were for two of 44,000 tons, also to be built for the Niarchos organization. Disclosure of plans for their construction was made only late in January by Vickers-Armstrong, Ltd., the British firm which will build them.

The latest orders with Bethlehem return to the United States the top position in large-tanker construction. The two 45,400-ton vessels will cost about $10,000,000 each. The 12 months' anticipated construction time is unusually short, a fact which was apparently a principal reason for placing the orders in the United States where tanker costs are higher. In addition, United Kingdom yards are booked to capacity.

The tankers will be built for North American Shipping & Trading, Ltd., of New York as agent for World Tankers Co., Ltd.

ECA Oil Aid Revealed

The Mutual Security Agency in Washington has summed up the activities of its predecessor, the Economic Cooperation Administration, and finds that during the 45 months of the Marshall plan the United States gave the European participants in the program $1,262,300,000 with which to procure oil in this country and abroad.

In addition, after the outbreak of hostilities in Korea the ECA provided $13,452,000 for petroleum products of which $10,084,000 went to the Chinese Nationalists on Formosa, $3,344,000 to Indio-China, and $23,000 to the Philippines.

MSA did not report separately the ECA contribution to the development of additional refining facilities in Europe, which was lumped in with funds provided for industrial productivity generally. It did show that guaranties had been issued for $19,118,000 to be invested in refining facilities abroad by American citizens.

A final breakdown of the authorizations for oil issued to the Marshall-plan countries by ECA during the life of the program, April 3, 1948, to December 31, 1951, shows the following distribution:

Austria, $3,600,000; Belgium-Luxembourg, $59,900,000; Denmark, $56,100,000; France, $389,600,000; Western Germany, $54,500,000; Greece, $24,200,000; Iceland, $1,700,000; Ireland, $13,300,000; Italy, $129,000,000; the Netherlands, $64,800,000; Norway, $36,100,000; Portugal, $8,600,000; Sweden, $66,200,000; Trieste, $12,700,000; Turkey, $4,800,000; United Kingdom, $331,100,000; and Yugoslavia, $5,900,000.

EUROPE

Hydrogenation Plant Output

West Germany's two former hydrogenation plants, at Gelsenkirchen and Wesseling, last year accounted for the processing of 1,116,000 tons (about 22,000 bbl. daily) of crude oil, or approximately a fourth of the throughput of the republic's refining industry.

Two other former hydrogenation

(Aerial view of Carteret, N.J.)

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plants, those of Scholven Chemie, A. G., and Ruhroel, G.m.b.H., are being rehabilitated for use in refining natural petroleum. Both plants were partially destroyed during the war.

The Scholven Chemie plant at Scholven-Buehr had a maximum production of 1,705,000 bbl. in 1944. The Ruhroel plant at Bottrop-Welheim had a 1944 throughput of 1,113,000 bbl.

France Bids for Tankers

By subsidies and greater steel-plate quotas, the French Government is seeking to encourage construction of French-flag tankers to lessen the currency drain from transporting oil in foreign vessels.

Another step forward in this program was the recent launching of a new 16,500-ton tanker, Saint-Patrice. The ship was built by Association Petroliere, subsidiary of Soc. Generale des Huiles de Petrole (S.G. H.P.) S.G.H.P. is one of the principal French refining companies and is affiliated with Anglo-Iranian Oil Co., Ltd.

The French tanker fleet, which totaled about 350,000 tons prewar, now aggregates 1,000,000 tons and is able to transport half the crude oil used by French refineries. Two obstacles to construction of tankers in French yards has been the lack of steel and the relative high price of the vessels. However, plate allocations to shipbuilders have been increased from 5,000 to 10,000 tons a month, and subsidies to shipyards voted by Parliament last year are soon to become effective.

LATIN AMERICA

Pemex Celebrates

Mexico reviews 5-years' growth of oil industry

THE fourteenth anniversary of the expropriation of foreign-oil properties in Mexico was observed March 18 with demonstrations, speeches, and a rally in Mexico Ciy.

The occasion brought a 5-year review of accomplishments of Petroleos Mexicanos from Sen. Antonio N. Bermudez, director-general of the state oil organization. He spoke at a rally attended by Pres. Miguel Aleman.

Bermudez said the 16 drilling contracts which Pemex has signed with foreign operators in the last few years represent a triumph for the petroleum policy of Mexico.

During the last 5 years Pemex has won indisputable international prestige by its progress, Bermudez said. Among the achievements of the Mexican industry since 1946 were: Crude reserves increased to 1,424,000,000 bbl., production increased to 78,780,387 bbl., or about 216,000 bbl. daily; refinery production increased to 56,780,000 bbl. or 156,000 bbl. daily; and exports up 22,393,622 bbl., or 61,000 bbl. daily.

Exploration.—Pemex now has 44 exploration parties in the field, and there are 178 favorable structures awaiting drilling. Construction of west coast refineries at Mazatlan, Salina Cruz, and Guaymas, awaits only availability of materials. This also is true of a 20,000-bbl.-daily catalytic cracking unit at Ciudad Madero and a 5,000-bbl. catalytic cracking plant at Minatitlan.

Pemex's program includes an additional 758 miles of natural-gas pipe lines and a natural-gasoline plant for northern Mexico. The various properties bought by Pemex since 1946 to consolidate the industry have a value of approximately $67,600,000.

Peruvian Oil Law Signed

The new Peruvian petroleum law providing for a 20 per cent export tax and a 50-50 split of profits has been signed by President Manuel Odria.

Though the legislation was hailed in Peru as establishing an open door to foreign oil capital, the oil companies themselves have taken a less enthusiastic attitude. Passage of the law culminated a controversy that has been going on intermittently in Peru for years over the issue of liberalizing petroleum legislation.

In Lima an official of International Petroleum Co., Ltd., the dominant company presently operating in Peru, described the new law as a step in the right direction and as being sound from a structural point of view. He said amendments could take care of needed modification, but that a decision on whether the company would launch a new program under its terms await the regulations which the government will promulgate to implement the law.

Industry sources take objection to several of the law's provisions. In general there is a question as to whether a 50-50 split is appropriate as applied to unproved wildcat territory. *(The Oil and Gas Journal, March 3, 1952, page 63).* It has been pointed out that not all costs are deductable for tax purposes and that the export tax is collected regardless of profit or loss.

MIDDLE EAST

Bank's Try Fails

Negotiations with Iran dropped after 3 months

THREE months of work by the World Bank to mediate the Iranian oil-nationalization dispute have ended in failure, at least for the time being.

Bank representatives have been seeking since late December to work out a plan which would allow at least temporary resumption of operations. The bank and the Iranian Government were never able to come to terms on the questions of the price at which the oil would be sold, who would manage the properties, and employment of British technicians.

While the bank's representatives paid a farewell call on Prime Minister Mossadegh and prepared to leave Teheran, the State Department in Washington insisted the settlement efforts had been "suspended" and not ended. State Department officials said enough progress had been made to warrant another trip by the bank's mission to the Iranian capital.

Bleak outlook. — Other reports provided little to support this optimistic view. In Teheran, Kazem Hassibi, a government official, said the bank's proposals were "virtually worse" than those offered last year by B. R. Jackson and the Stokes-Harriman mission.

A member of the joint Iranian oil board said flatly that negotiations are "now ended." However, a joint Iranian-World Bank statement said cautiously that the mission would return to Teheran if it appeared that further progress could be made.

The breakdown of the bank's negotiations came almost exactly a year from the date on which the Iranian Parliament approved its first oil-nationalization law and set in motion the chain of events which led to the shutdown of the industry and the expulsion of Anglo-Iranian Oil Co., Ltd., personnel last September. The bank's effort was the fourth attempt made to work out a settlement. Jackson, an Anglo-Iranian official, headed the first group to go to Teheran. Later Averell Harriman as President Truman's personal representative and Richard Stokes, British Government lord privy seal, went to Teheran.

Iranian concern. — After the breakdown of the negotiations with the bank was disclosed, some concern was evident among certain influential Iranians as to the wisdom of the government's unyielding position. The Iranian senate called an extraordinary session and was expected to ask the prime minister for a full explanation.

On the other hand, leaders in the Iranian Government were making every effort to justify the government's actions.

PERSONALS

Warren Honored

Tribute paid Tulsan on his company's 30th anniversary

LONG-TIME friends and business associates from all parts of the country were among the more than 500 people who attended a testimonial banquet to W. K. Warren at Tulsa March 15 on the occasion of the thirtieth anniversary of the founding of Warren Petroleum Corp.

The Warren organization started as a natural-gasoline-brokerage concern on March 15, 1922, the original office force consisting of Warren, with Mrs. Warren as secretary. Expanding steadily, the Warren company for several years operated exclusively in a brokerage capacity, filling a need for orderly national marketing of the products of several natural-gasoline manufacturers in sales to refiners and jobbers.

In recent years the company has become a large manufacturer in its own right but has also continued to market output of natural gasoline and related products for several companies. In 1951 the company's own production and marketing sales totaled 1¼ billion gallons about equally divided between natural gasoline and liquefied petroleum gases.

In 1946 Warren negotiated the purchase of the Hanlon companies, thereby greatly increasing its production of light hydrocarbons along with substantial crude-oil output in the Southwest. Crude-oil production has since been expanded, a separate company being operated for that purpose. More recently the Warren company purchased Devonian Co., one of the oldest producing concerns of the Mid-Continent area.

To carry on its marketing operations the company has become one of the largest owners of tank-cars with terminal facilities at Gulf Coast and East Coast points for the coastwise and export movement of products. After World War II the company converted a cargo ship to provide for the first tanker shipment of liquefied petroleum gases.

While expanding his company from a $3,000 to a $100,000,000 concern in 30 years, Warren has been able to devote considerable time to civic and religious work. These accomplishments were stressed at the banquet by friends familiar with these activities. He is a director of the First National Bank & Trust Co. of Tulsa and the Missouri, Kansas and Texas Railroad. The Warrens are the parents of six daughters and one son.

In accepting an antique tray from friends at the banquet, Warren paid tribute to his associates, several of whom have been connected with the Warren organization for many years, including J. A. La Fortune, executive vice president; H. E. Felt, H. W. Harts, S. I. Hulse, J. A. Padon, J. E. Allison, vice presidents; A. J. Murphy, treasurer; and H. E. Anderson, First National Bank, Chicago, director.

E. DeGolyer, widely known operator and consultant, was made a honorary member of the American Institute of Mining and Metallurgical Engineers at a dinner March 20 in Dallas, attended by members of the petroleum division of the institute. DeGolyer has been active in A.I.M.E. activities for many years and formerly served as president of the organization. **M. L. Haider,** of Standard Oil Co. (N. J.), New York City, newly elected A.I.M.E. president, was principal speaker at the dinner.

Henry Eichner has succeeded **H. E. Crane,** who retired, as manager of the distilling department at Shell Oil Co.'s Martinez refinery. Eichner formerly was manager of the refinery's asphalt department.

Harold J. Holmquest, geologist for Magnolia Petroleum Co., at Midland, Tex., is on leave of absence attending Michigan State College where he will receive his M.S. degree in geology this spring.

Wilbur O. Henderson, superintendent for Ohio Oil Co. at Reed City, Mich., has been transferred to Robinson, Ill., and promoted to assistant district superintendent.

M. Ray Bane, formerly core-laboratory technician for the Petroleum Engineering Association at Pasadena, Calif., has joined Union Oil Co. of California as a paleontologist at Houston.

James W. Rockhold, formerly reservoir engineer for The Texas Co. at Tulsa, has joined the production division of National Cooperative Refinery Association as chief engineer. His headquarters will be at Great Bend, Kans.

C. D. Swinson, formerly tool pusher for Jess W. Wright at Wichita Falls, Tex., has joined Fox-Witherspoon Drilling Co. at Abilene, Tex., in the same capacity.

Frank W. Ficklin, formerly field engineer for Sunray Oil Corp. at Odessa, Tex., has joined Hiawatha Oil & Gas Co. at Bowie, Tex., as field superintendent.

B. F. Bohnhardt has been advanced to supervisor of mechanical design, and **F. E. Funke** made supervisor of electrical design, in the Los Angeles offices of Southern California Gas Co.

DUNCAN

Charles P. Duncan, Jr., has been named chief geologist of Manufacturers Light & Heat Co. and associated Pittsburgh Group gas companies in the Columbia Gas System. He succeeds **Frank A. Boyd.** Duncan, who joined the gas company in 1949 as a geologist, has been assistant chief geologist for the past 8 months.

G. W. Bond, F. R. Brooks, S. Groennings, F. H. Stross, and **F. T. Weiss** have been promoted to supervisors in the research and analytical department of Shell Development Co.'s Emeryville, Calif., laboratories. Advanced to supervisors in the development and experimental-plants department were: **H. A. Cheney, D. D. Davidson, F. D. Moss,** and **J. C. Rapean.**

L. C. Forrest has joined M. J. M. & M. Oil Co. as chief geologist at Bakersfield, Calif. Prior to his new job he was senior research geologist for General Petroleum Corp., district geologist for Chanslor-Canfield Midway Oil Co., and before World War II was a Richfield Oil Corp. geologist for 6 years.

C. G. Cortelyou has been appointed chief design engineer of General Petroleum Corp.'s engineering department at Los Angeles. He succeeds **A. K. Brumbaugh,** who has joined the refinery-engineering department of Socony-Vacuum Oil Co., Inc., New York. Cortelyou, with General Petroleum since 1938, has been successive-

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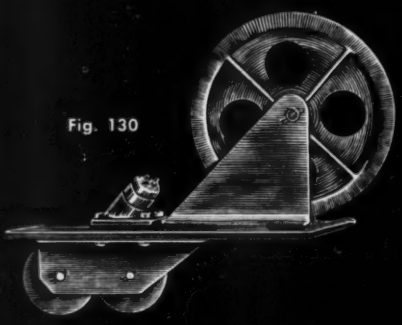
Fig. 130

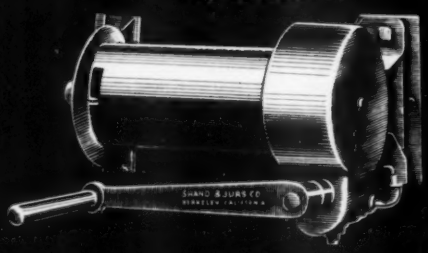


S&J Swing Line Cable Sheave Bracket, Fig. 130, employs cast iron stuffing box. Also available with oil seal for moderate tank pressures.

S&J Cable Winch, Fig. ST-4380, utilizes machine cut, anti back-lash gears which run in an oil bath. Handle designed for maximum mechanical advantage.

S&J Double Elbow Swing Joint, Fig. ST-235, is mounted on tank shell only. Settling or shifting tank bottom can not affect its easy swing.

Fig. ST-4380



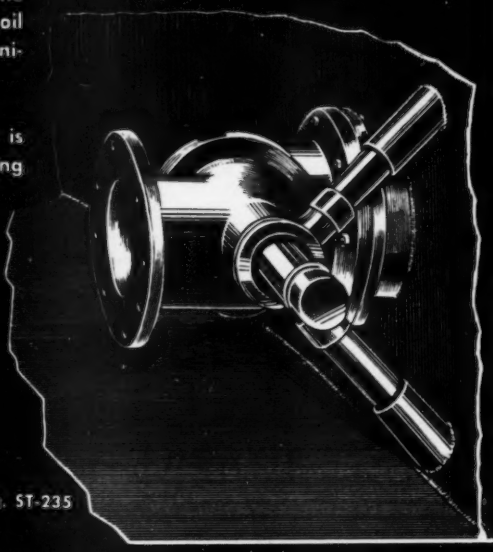


Fig. ST-235

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PERSONALS

ly a measurement engineer, job engineer, and project engineer at the department's Vernon, Calif., headquarters.

Murray C. Moffatt, special petroleum engineer for Gulf Oil Corp., has resigned to become Fort Worth, Tex., representative of Magnet Cove Barium Co. **J. D. Walker,** petroleum engineer at Fort Worth for Gulf, has been named to succeed Moffatt.

R. Lee Hunter has been appointed to the newly created position of director of geological training for Continental Oil Co. at Ponca City, Okla. Hunter, who has been with Conoco since 1936, served as geologist and core-drill foreman for 11 years in Oklahoma and Kansas before becoming assistant to the chief geologist in 1947.

William C. Whaley, a vice president and director of Sunray Oil Corp. at Los Angeles, has been transferred to the firm's general offices in Tulsa, where he will become a member of the firm's executive committee and chairman of the operating committee. **R. E. Foss,** vice president of Sunray's

WHALEY

FOSS

West Coast division, of which Whaley was formerly manager, has been named vice president and manager of operations there. **E. H. Wright,** president of the company, is giving up the chairmanship of the operating committee to Whaley, and **Paul E. Taliaferro,** Sunray director and vice president, will be vice chairman of the committee. Whaley, whose oil experience dates back to 1910, joined Barnsdall Oil Co. in 1924. When Barnsdall was merged with Sunray in 1950, he became associated with Sunray as a director and vice president. Foss joined the former Barnsdall organization in 1935 as petroleum engineer and has been successively production foreman, drilling engineer, and vice president.

E. W. Christian, assistant general manager of Imperial Pipe Line Co., Ltd., at Edmonton, Alta., has been promoted to general manager. He succeeds **S. C. Coultis,** vice president and general manager, who has retired after 35 years in the Alberta petroleum industry.

FOREIGN VISITORS.—Foreign guests who attended the recent Houston Chapter of Nomads meeting are shown above. Left to right: R. de Panafieu, Societe Nationale des Petroles Aquitaine, Paris; Norman C. Brown, Sted Bros., London; James L. Wall, Jr., The Texas Co., Caracas, Venezuela; and L. A. Allaud, Schlumberger Well Surveying Corp., Venezuela.

Charles A. Houston has been appointed district geologist in the southeastern district exploration office of Stanolind Oil & Gas Co. at Jackson, Miss. He replaces **B. F. Baldwin,** who has been transferred to Albuquerque, N. M., as district geologist of the Northwest New Mexico-Arizona district.

William B. Macey has been named chief engineer of the New Mexico Oil Conservation Commission.

W. S. Young, of Wellsville, N. Y., has joined Delta Drilling Co. as general superintendent in the Bradford, Pa., area.

Joseph Neely, district geologist for Magnolia Petroleum Co. at Tyler, Tex., has been transferred to Midland, Tex., as district geologist. **Wayne R. Hammond** has been transferred from Magnolia's Dallas office to Tyler as district geologist in charge of the East Texas district. **W. Lloyd Haseltine** has been moved to Dallas as regional geologist in charge of the development section. He was formerly district geologist at Mt. Vernon, Ill. In the company's producing division, **J. Edgar Middleton** has been transferred from the petroleum engineering department, Falfurrias, Tex., producing district, to the Pegasus district in West Texas, as assistant production foreman.

W. T. Kennedy, formerly assistant to the general superintendent of production for Ohio Oil Co. at Findlay, Ohio, has been appointed assistant division superintendent in the Los Angeles division at Bakersfield, Calif. **R. E. McMillen,** petroleum division engineer at Houston, has been named assistant to the general superintendent succeeding Kennedy. **L. H. Shearer,** petroleum engineer at Houston, has been promoted to division petroleum engineer at Houston; and **J. H. Shonk,** formerly assistant district superintendent at Robinson, Ill., has been appointed special assistant to the division superintendent of the Terre Haute, Ind., division.

R. E. Irwin, formerly chief chemist of British American Oil Co.'s manufacturing department, is now manager of the new Montreal petrochemical plant of B.A.-Shawinigan, Ltd. **R. O. Campbell,** formerly technical assistant in British American's marketing department, succeeds Irwin as chief chemist.

Dr. Harry H. Power, petroleum-engineering professor at the University of Texas at Austin, Tex., has been elected chairman of the American Institute of Mining and Metallurgical Engineers' Mineral Industries Education division. The division's work covers training and research in petroleum, mining, geological, ceramic, geophysical, and metallurgical engineering.

J. D. Wheeler, district manager at Midland, Tex., for Ohio Oil Co., has been transferred to Houston as assistant to **R. C. Gwilliam,** division manager. Other changes include: **Coe Mills,** district geologist at Midland, replaces Wheeler; **D. W. Franklin,** geologist at Abilene, Tex., replaces Mills at Midland; and **Alfred Giles,** geologist at Midland, replaces Franklin at Abilene.

W. A. Wilson, Web Wilson Oil Tools, Inc., has been elected president of the Los Angeles Chapter of Nomads, succeeding **Earl Rees,** of Byron

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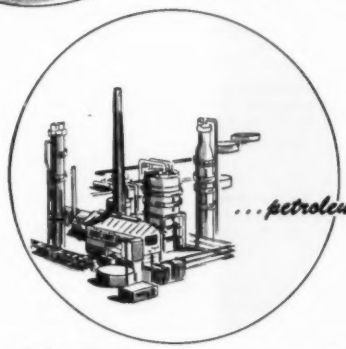
EQUIPMENT

. . . from oil and gas fields

H_2S content of sour gas converted to elemental sulfur. A Foster Wheeler sulfur recovery plant in one location is producing over 300 tons/day of elemental sulfur.

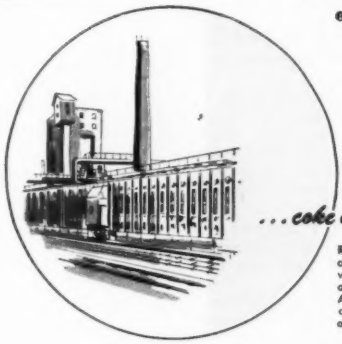


. . . petroleum refineries

H_2S gases previously "flared" and the sulfur wasted, now recovered. Two Foster Wheeler sulfur recovery plants for this service now under construction.

The unprecedented demand for Sulfur has reached a point where the world's available supply is seriously threatened. Thus, the need to find new sources for this vital element becomes one of the major items on today's agenda for full-scale production for both defense and civilian needs.

Fortunately, there is a great new source. Instead of allowing it to vanish into thin air, Sulfur is being recovered profitably from H_2S bearing gases with Foster Wheeler equipment. A quarter million tons of Sulfur per year will be recovered by Foster Wheeler plants installed or now under construction.



. . . coke ovens

Removal of H_2S from coke oven gas not only enhances the value of the gas but provides a source of elemental sulfur. A Foster Wheeler sulfur recovery plant is in operation on this service.

FOSTER WHEELER

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PERSONALS

Jackson Co., who has been transferred to New York as export manager. **W. A. Sawdon** was appointed executive secretary, succeeding **John Rife** of Web Wilson.

F. O. Walkling, Shell Oil Co. of Canada, has been transferred to Shell's Montreal East refinery in Quebec as a technologist.

Maury M. Travis, geologist for the Federal Power Commission in Washington, D. C., has been transferred to the U. S. Geological Survey, Conservation Division, at Washington.

HEMPHILL

Herbert A. Hemphill, formerly district geologist for Magnolia Petroleum Co. at Midland, Tex., has resigned to take over the presidency of Texas Eastern Production Corp., wholly owned subsidiary of Texas Eastern Transmission Corp. He succeeds **R. H. Hargrove,** who resigned in order to devote his time fully to the parent company of which he is president and director. Hargrove will also continue as a director of the production company. Hemphill, who has been with Magnolia for the past 17½ years, will be headquartered at Houston.

Walter L. Erwin, geologist for Sun Oil Co., has been transferred from Truth or Consequences, N. M., to Abilene, Tex.

W. L. Webb, formerly administrative director of the Whiting Laboratories of Standard Oil Co. (Ind.), has been named acting administrative director of the firm's research department in Chicago. Replacing him at Whiting, Ind., is **R. F. Baldaste,** who is assisted by **J. G. Hunter. R. J. Mahassek** has been transferred from the firm's Wood River, Ill., refinery to the Chicago office as head service engineer.

G. H. Koelling has been named general foreman of the heavy-oils group at the Whiting, Ind., refinery of Standard Oil Co. (Ind.). Also in the heavy-oils division, **W. W. Forbes** has been promoted from assistant general foreman of the filtering-oil department to general foreman of the stills and labor department. He is succeeded by **R. T. Bell,** transferred from the engineering division. **Dr. R. R. Wilson,** assistant superintendent of the heavy-oils division, has been appointed superintendent of the projects division. **P. T. Oak,** formerly in the Chicago office, succeeds Wilson.

Chester M. Bonar, geologist for Atlantic Refining Co., has been transferred from Lusk to Casper, Wyo.

L. P. Blaser, project engineer for British American Oil Co., Ltd., at Toronto, Ont., has been transferred to Moose Jaw, Sask., as assistant manager of the company's refinery there.

Harvey Fifer, formerly stationed at the Oleum, Calif., refinery of Union Oil Co., has been transferred to Los Angeles to head a new byproducts chemical division.

Philip L. Ferguson, junior geologist for Stanolind Oil & Gas Co. at Casper, Wyo., has been transferred to Scottsbluff, Neb.

Don Gilkinson has been appointed Wyoming area manager for Gulf Oil Corp., succeeding **Jed Maebius** who was recently transferred to Tulsa. **Tom Wilson** will be area geologist at Wyoming.

Tom G. Lewis, district superintendent for Pan American Production Co. at Charenton, La., has been transferred to Willimar, Tex., in a similar capacity.

Robert O. Vesper, geologist with Carter Oil Co., has been transferred from Manhattan, Kans., to Morrilton, Ark.

Richard M. Kobdish, district superintendent of production at Crane, Tex., for Sinclair Oil & Gas Co., has been promoted to assistant division superintendent of production of the West Texas-New Mexico division. His headquarters will be in the division office at Midland, Tex.

Dr. Judson Swearingen, nationally known for his work in uranium-plant construction during the war, has been named director of petroleum technology for the Southwest Research Institute. Dr. Swearingen has been the institute's chairman of chemical engineering and one of its key scientists and engineers almost since it was founded in 1947.

Ralph H. Starrett has been promoted to division superintendent in the products pipe-line department of Standard Oil Co. (Ind.). **Francis W. Mann** succeeds him as district superintendent at Council Bluffs, Iowa.

E. T. Lindsey, assistant manager of the chemical plant at Bishop, Tex., for Celanese Corp. of America, has been promoted to plant manager, relieving **Kenneth D. Bowen** of Corpus Christi, Tex., who last year was made manager of all plant operations for the chemical division. Lindsey will move to Corpus Christi. **A. R. Cochran** was promoted to chemical-division engineer to coordinate engineering and construction for all plants. **Drew Mayfield** was promoted to plant-process engineer for the chemical division and will continue for the time being to handle process work at Bishop. **R. E. Gautreaux** was promoted to plant engineer at Bishop, succeeding Cochran.

DEATHS

Royal R. Bush, 74, retired independent operator, died recently in Pasadena, Calif. Bush organized Bush-Voorhis Oil Co. in California in 1922, and retired in 1945 when he sold his interests to General Petroleum Corp.

F. F. Gregory, sales-promotion manager of A. O. Smith Corp. at Milwaukee, died there recently.

Orion N. Miller, 52, construction engineer for Universal Oil Products Co. at Long Beach, Calif., died there March 11. He had been with the firm for 30 years and had built refineries in the British West Indies, Dutch West Indies, Argentina, Soviet Russia, and many places in the United States.

James LeRay Stebbins, 58, former Tulsa oil man, died March 13 at Jackson, Miss. Miller was first associated with Gladys Bell Oil Co., later becoming an independent at Tulsa, Okmulgee, Okla., and Evansville, Ind. He moved to Jackson 12 years ago.

Clio Leonard Wood, 76, formerly with Standard Oil Co., died recently in San Bernardino, Calif. Prior to joining Standard he had been with Carl Meyer Oil Co. and Signal Oil Co. as field superintendent.

Cliffton C. Stevens, 53, Gulf Oil Corp. accountant, died March 11 at Fort Worth, Tex.

Hubert V. Cocke, 43, of Union Oil Co., was killed in an automobile accident at Long Beach, Calif., on March 11.

William J. Kennedy, 53, district materials supervisor for Carter Oil Co. at Purcell, Okla., was killed in an automobile accident 5 miles south of Blanchard, Okla., March 14. He had been with Carter for nearly 18 years.

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January 2, 1952

VIA AIR MAIL

The Utah Construction Company,
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Attention: Mr. N. H. McNamara

Gentlemen:

In reply to your Air Mail letter of December 29th, we are pleased to say that we recently purchased two new 750 Failing drill rig units from the George E. Failing Supply Company. The performance has been excellent and the cost of operation very moderate.

We have been drilling 6" holes down to a depth of 1170 feet and larger diameter holes of 12" down to 350 feet in sands, gravels and clays, setting 12" casings (with a weight of 54 pounds to the foot) with floating equipment.

The nature of our work has been varied, including undisturbed soil sampling for foundations, all types of borings, drilling test water well, concrete coring, drilling from barges in Mobile Bay, and all types of engineering for subsurface investigations for dams and lakes and coring for salt domes.

We also recently purchased a new Failing 1500-B heavy duty drill rig with which we can bore down to 7000 feet on 6" holes. We can also highly recommend this equipment because ours has given us excellent service.

We also recently completed a diamond core drilling job in West Texas near Pecos, drilling 1" holes in sulphur beds down to 400 feet with an average of 120 feet per day in a 10 hour day. This was continuous coring.

If you will give us more information on the type of work you intend doing, we will be glad to give you more information on the subject.

We are available for any contracts that you might be interested in subletting. If we can be of any service to you in any way, please call upon us.

Yours very truly,

A.W.WILLIAMS INSPECTION COMPANY

By L R Johnston

LRJ/ncw
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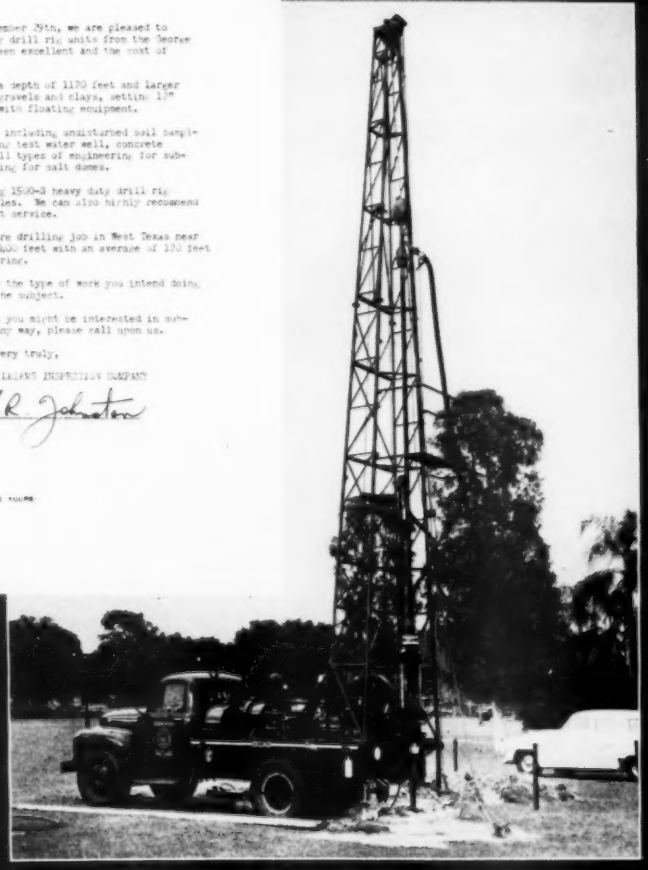

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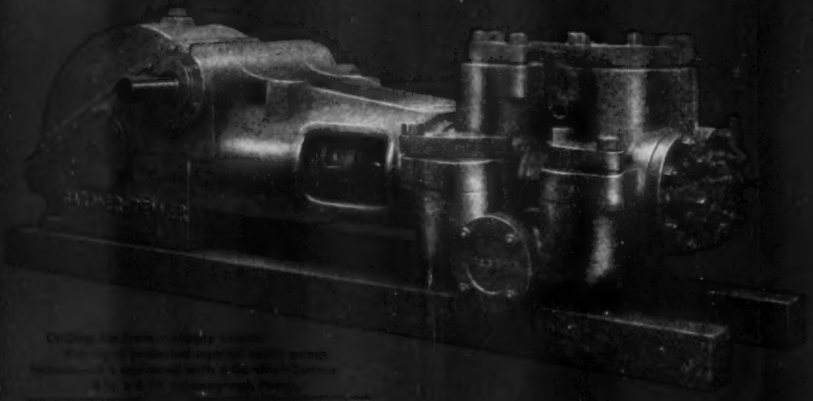
SEISMOGRAPH PUMPS...



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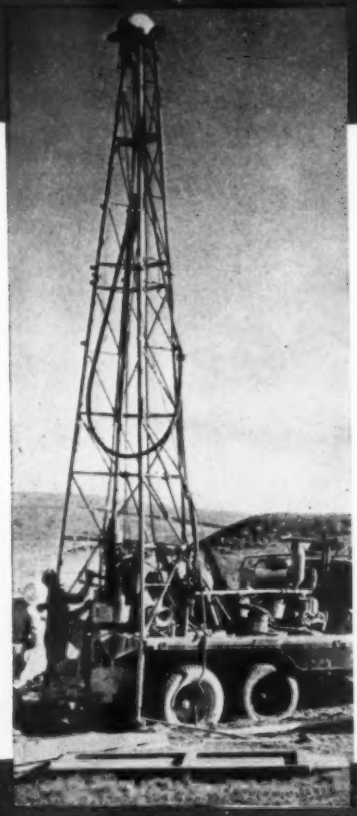

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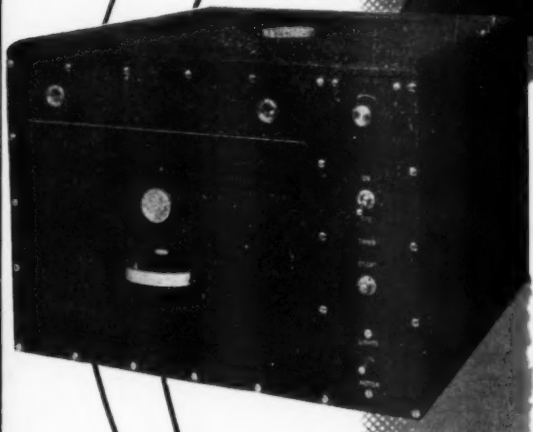

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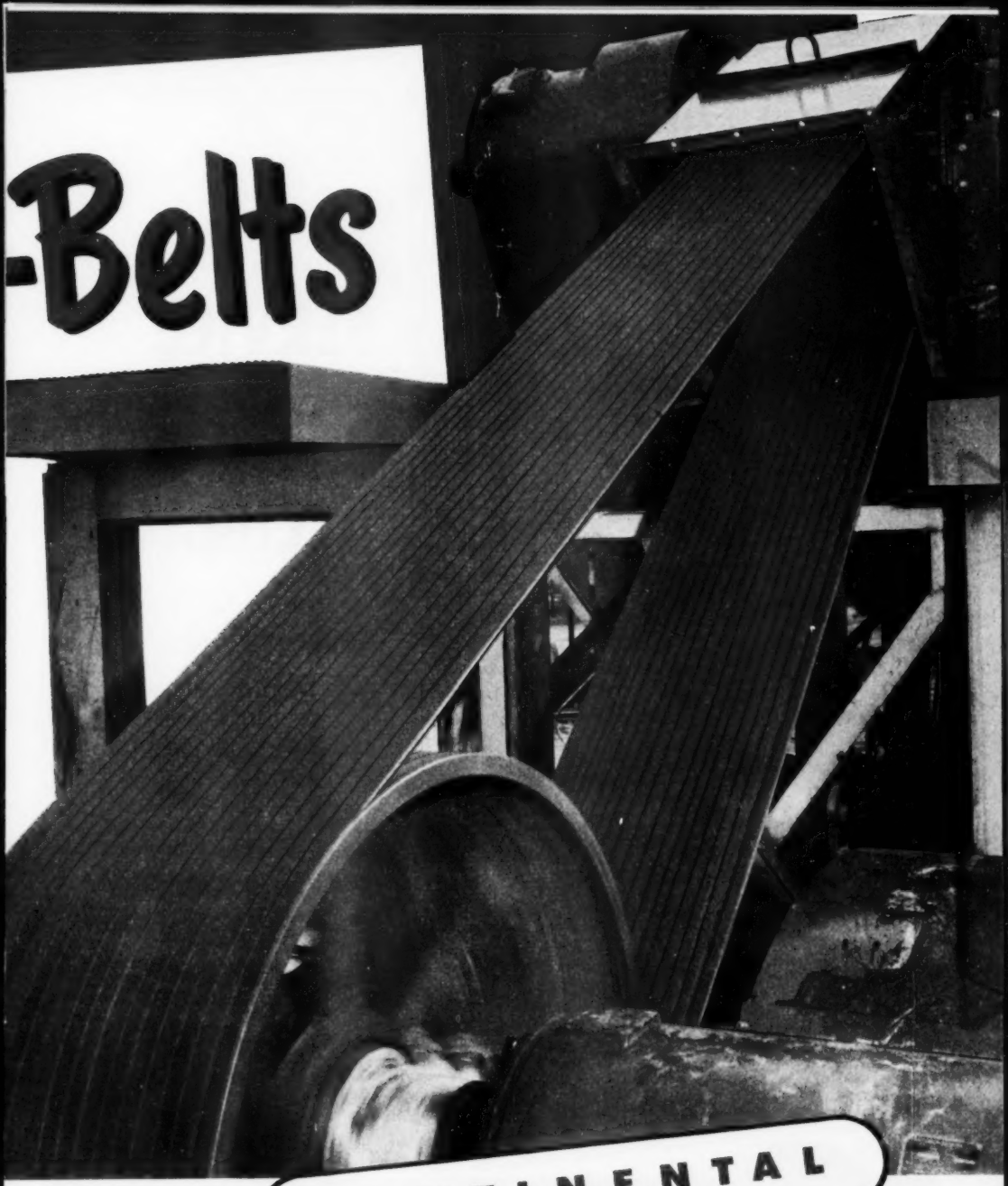

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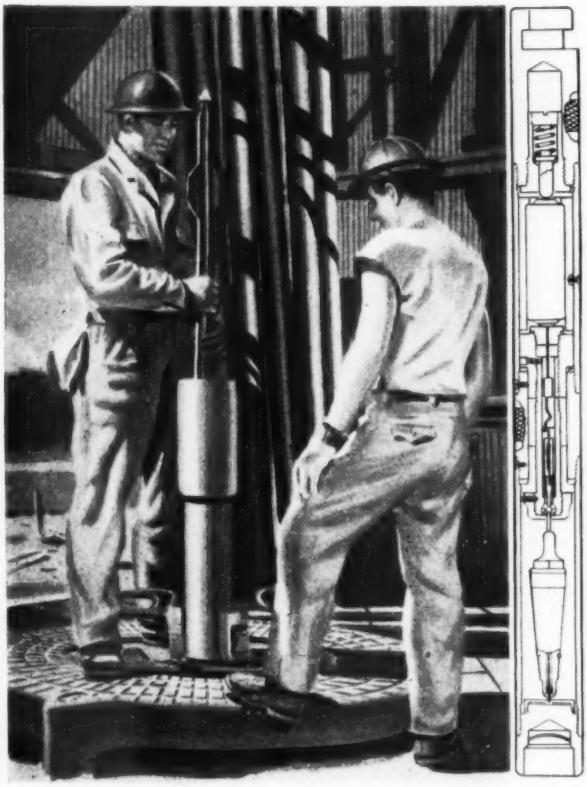

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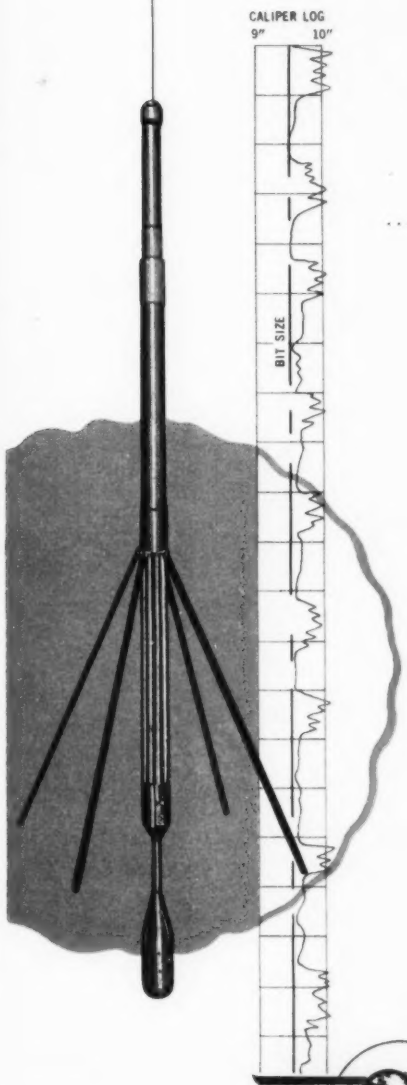

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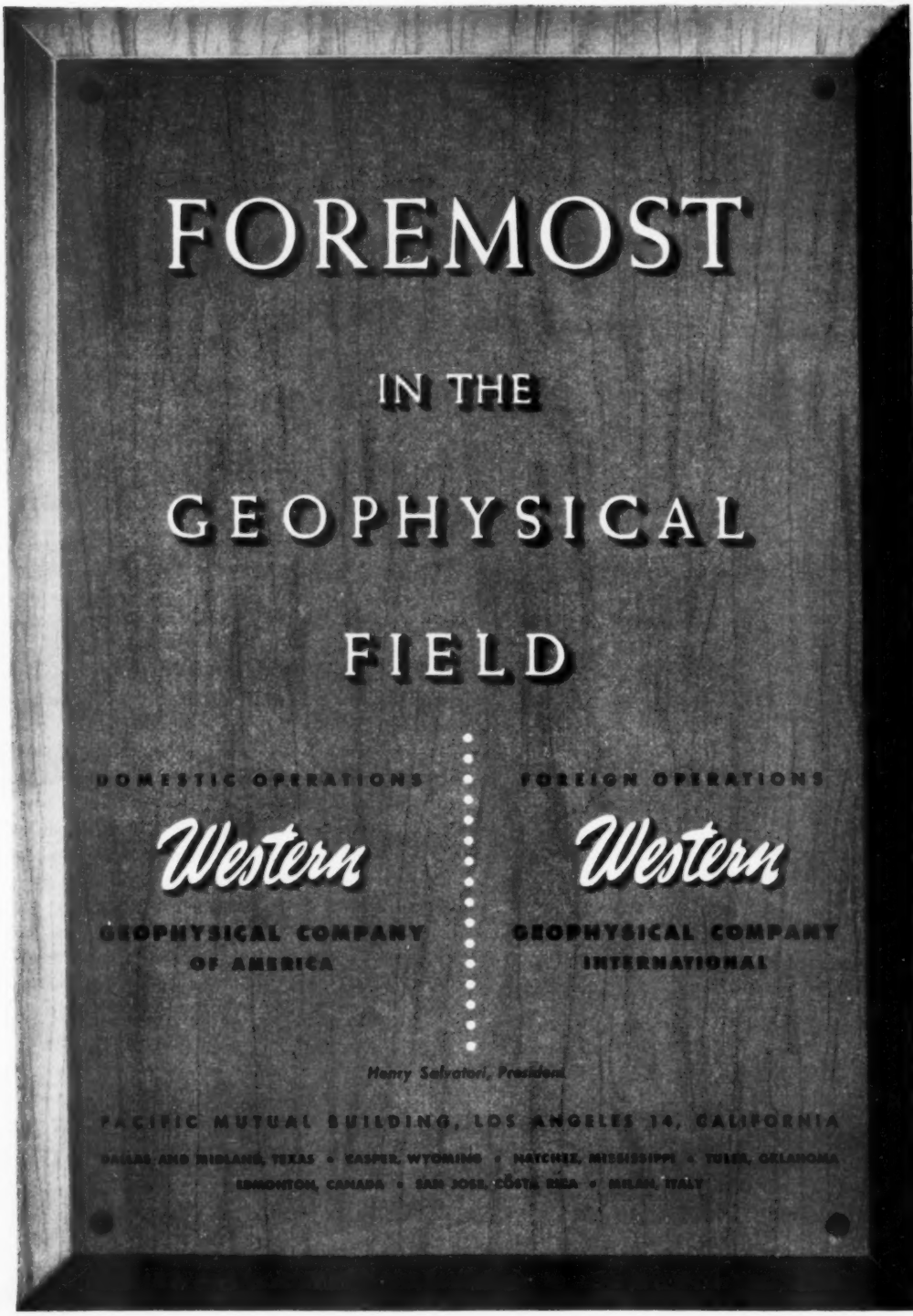
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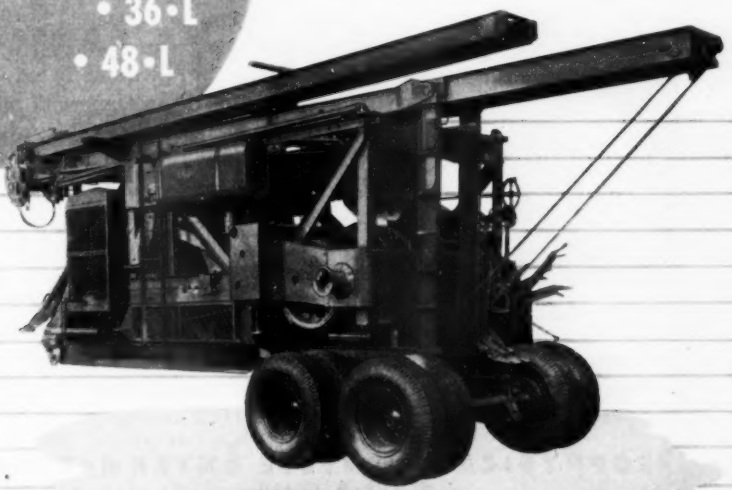

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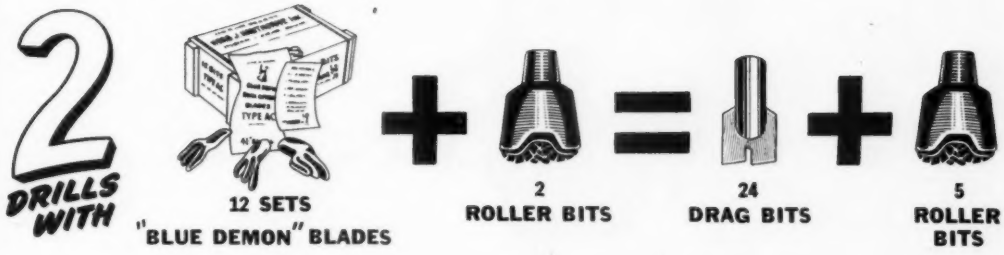

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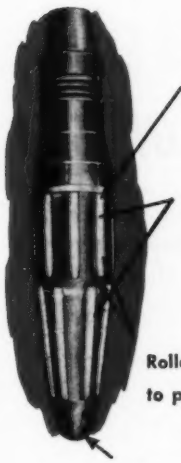

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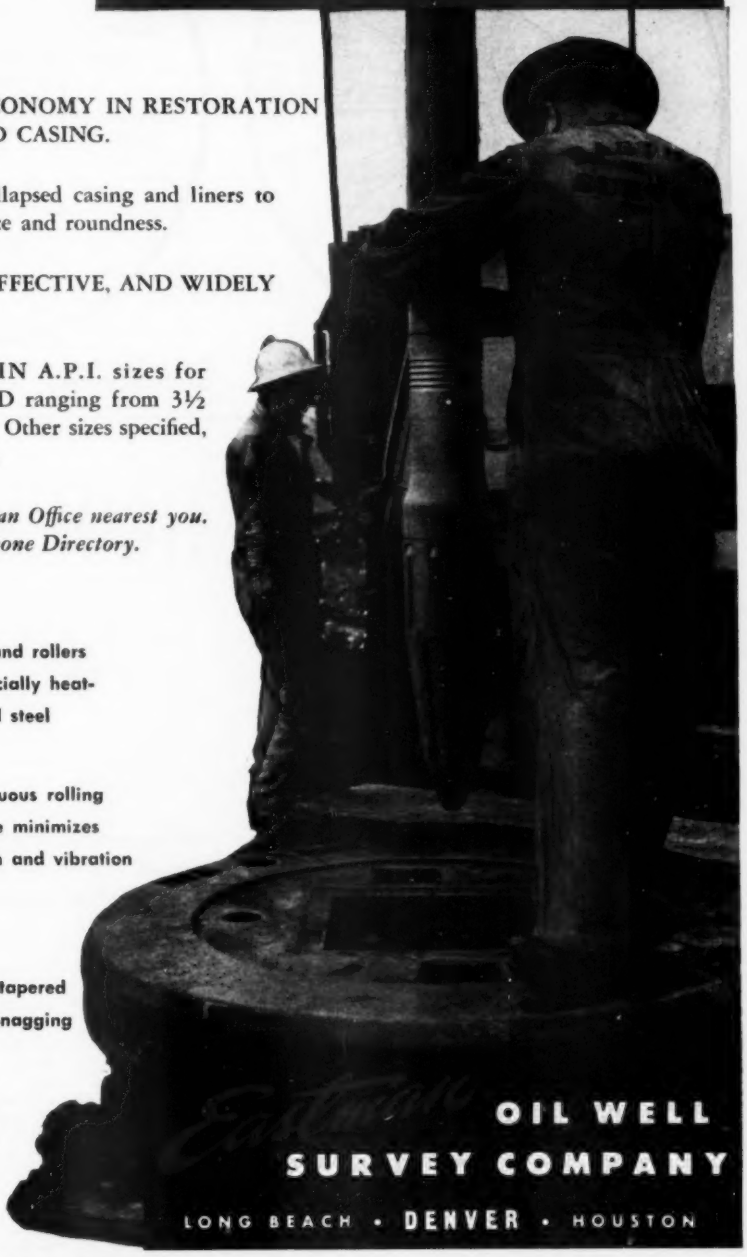

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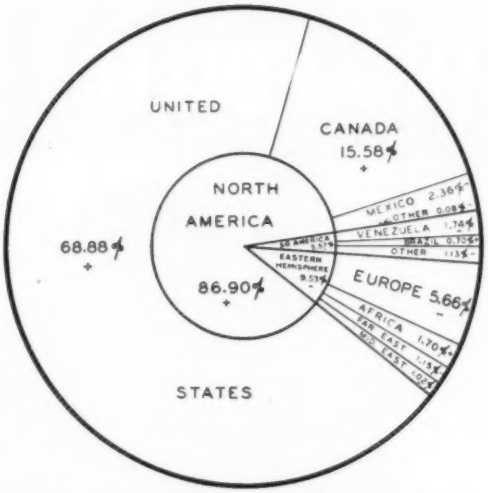

Fig. 2—World distribution of seismograph operations in 1951.

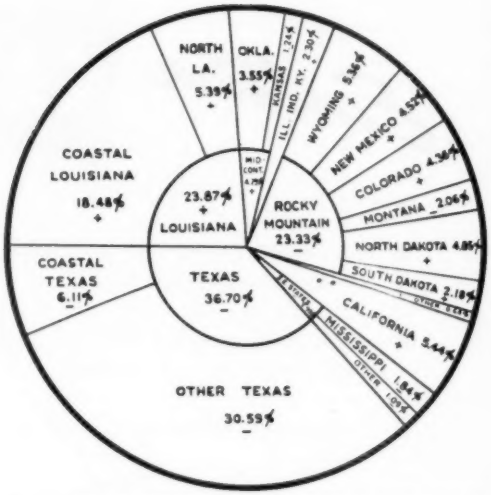

Fig. 3—Distribution of 1951 seismograph operations in the United States.

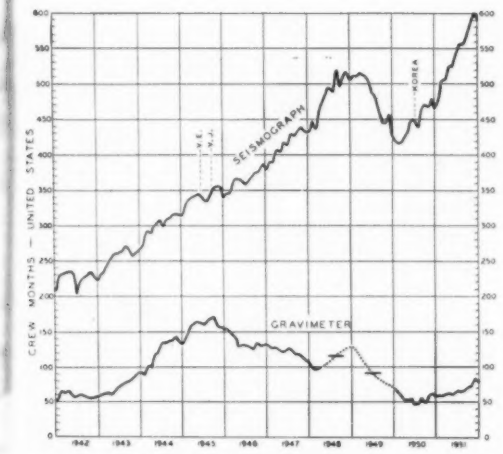

Fig. 1—Monthly variation in seismograph and gravimeter crew-months in the United States.

GEOPHYSICAL ACTIVITY IN 1951

"In accomplishing the increase which occurred last year, the geophysicists have accomplished something of a miracle."

by E. A. Eckhardt*

UNPRECEDENTED is the word which most aptly describes the expansion of geophysical activity which took place during 1951. The seismograph work done everywhere by the oil industry during the year required the full-time services of 791 crews, an increase of 134 crews or 20.4 per cent over 1950. Gravity work was also done in substantially greater volume during 1951, requiring the full-time services of 123 crews, an increase of 13 or approximately 12.2 per cent over 1950.

The number of crews reported as operating in the United States is plotted on a month-by-month basis for both seismograph and gravity in Fig. 1. The chart covers a period of 10 years and shows vividly that at no time during this period, and in fact during any other, did the number of seismograph parties rise at so rapid a rate. The increase in gravity operations was less pronounced, but was strongly upward for the period.

The chart shows at the peak of November, 600 seismograph parties working in the United States. The slight drop in December is of no significance. Such drops have occurred at the same season in practically every year and are of a seasonal character. If during all of 1952 seismograph work were done at the year-end rate of 1951, without further increase, the 1952 rate would exceed the average 1951 rate by approximately 10 per cent. Actually it is to be anticipated that the increase will be moderately greater than this.

*Gulf Research & Development Co., Pittsburgh. Report of the Committee on Geophysical Activity of the Society of Exploration Geophysicists. Members of this committee are A. A. Brant; Herbert Hoover, Jr.; D. C. Skeels, and E. A. Eckhardt, chairman. Presented at the Los Angeles meeting of the society, March 24, 1952.

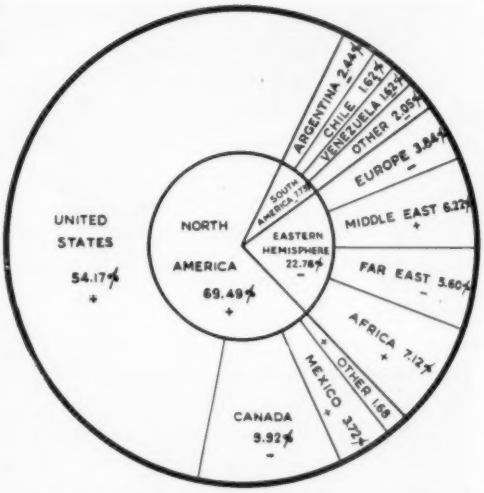

Fig. 4—World distribution of gravimeter operations in 1951.

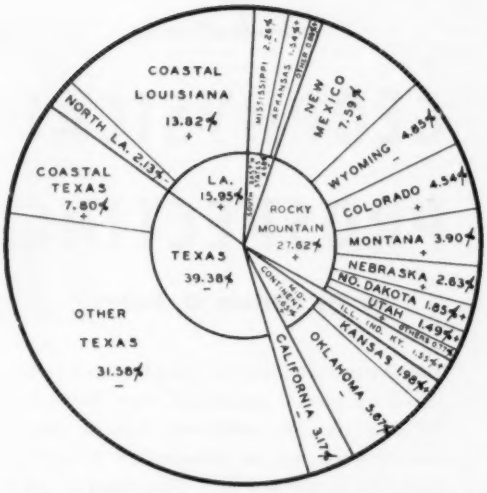

Fig. 5—Distribution of 1951 gravimeter operations in the United States.

In accomplishing the increase which occurred last year, the geophysicists have accomplished something of a miracle. Their number is not capable of expansion at will. A geophysicist is the product of training and experience. The acquisition of both takes time. The number of technically trained men that became available from the colleges and universities last year was far short of the demand for them by all industry, and the shortage had its full effect in limiting additions to the geophysical forces. The registration of the students now in the schools makes it clear that in the face of rising demand, the supply of graduates in the sciences and engineering will be decreasing for several years to come. The availability of suitably trained and experienced men is bound to prove a major obstacle in the maintenance and further expansion of geophysical services.

If you will take your hair down with me, you will admit that geophysicists, on the average, are currently not doing the best possible job. That this is so is not particularly their fault. There just are not enough of them to handle the volume of work there is to do. Most of them have to keep track of more kittens than can be kept neatly tucked away in the basket. One must not be surprised if some of the kittens go astray.

Planning necessary.—While this is a familiar story to most of us who are directly engaged in wrestling with these problems, there is need that it be fully understood also in other quarters. The intelligent expansion of geophysical services requires long range planning so that there is time to train men and give them the experience they will need to handle their jobs successfully. It is also important that each trained and experienced geophysicist be assigned in a manner to make the most effective use of this training and experience. There are not enough of them to go around; none of them should be wasted.

What has just been said about the manpower situation in our business when viewed against the background of our rearmament economy deserves the most careful consideration of our draft boards and the military authorities. Unless they, as well as industry, recognize that the pool of technically trained men is well below the needs of the country and temper their drafts from the pool accordingly, the vital defense effort will suffer. In the national interest they, too, have the obligation to make the best possible use of their technical training and experience when such men are called to active military service. Unless this obligation is recognized and made an integral part of selection policy, an already critical situation could easily become disastrous. It is reassuring to note that reasonable progress in this direction is being made. At best, however, the state of affairs can only be described as spotty.

Technologists essential.—Much has been heard in recent years from Gobble-de-gook Center about equality of sacrifice or the equal distribution of the burden. It is an idea to which all of us can readily agree in principle. From some of its propounders one gets the impression that this is of first importance, a requirement to which all others must be subordinate. In truth our greatest need is to win the struggle in which we are engaged.

E. A. ECKHARDT

In sheer weight of manpower we are outnumbered, and we can hope to win only by superior use of our technology and technologists. Should we take technologists out of technology in order that equality of sacrifice may be more completely achieved? A complementary question is, "Should we permit anything that will make the winning of the struggle more uncertain, lengthen its duration, and increase its cost?" An intelligent answer to the second question automatically provides an answer to the first. This answer may not be socially palatable, but we had better heed it and thereby improve the chances of saving our skins.

The question of geophysical per-

(Continued on page 209)

Introduction to

GEOPHYSICAL PROSPECTING

by Dr. Milton B. Dobrin

This Oil and Gas Journal presentation is published by special permission from McGraw-Hill Book Co., Inc., publishers of Milton Dobrin's "Introduction to Geophysical Prospecting." This brand-new text, elementary in approach and requiring no mathematics beyond trigonometry, presents the fundamental principles and operations of all standard methods of geophysical prospecting. The material here represents excerpts from several chapters of this 435-page book ($7.00).

GEOPHYSICAL prospecting is the art of searching for concealed deposits of hydrocarbons or useful minerals by measurement, with instruments on the surface, of the physical properties of material within the earth.

One of the newest branches of applied science, geophysical prospecting has become within the past three decades a weapon of first-rank importance in man's incessant struggle to maintain and increase his yield of fuels and raw materials from the untapped stores hidden beneath the earth's surface. Most spectacularly successful as a tool in the search for petroleum, geophysics can also be credited with substantial returns in the exploration for minerals.

Since 1926, the year that marked the first discovery of oil at a location selected on geophysical indications, activity in geophysical prospecting has expanded at a phenomenal rate. The past quarter century has also seen vast improvements in prospecting technique. These have resulted from increasing competition as well as from the continually stiffening challenge of deposits remaining to be discovered as the sources easiest to locate at any time are progressively found and exploited. The extent to which the challenge has been met in the case of petroleum is illustrated by the fact that more than half the 58.5 billion barrels of oil discovered in the United States prior to 1948 was first located by geophysical means.

"Introduction to Geophysical Prospecting" is primarily intended for four groups of readers: (1) students of geology and mining who expect to enter the field of petroleum or mineral exploration; (2) professional geologists, mining engineers, or executives engaged in exploration, whose work involves contact with geophysics and who feel the need for further instruction in the subject; (3) professional geophysicists who desire a broader view of all phases of geophysical explorations, particularly those outside their own field of specialization; and (4) students preparing for a career in geophysics, who want a general survey of geophysical prospecting as an introduction to their more advanced and more specialized course in the subject.

With the demand for petroleum and minerals at its all-time peak and with new sources to be found by conventional surface geology vanishing except in the most remote parts of the earth, the major burden of finding future reserves rests upon geophysics. But the geophysicist cannot handle the job alone. His efforts must be closely coordinated with those of the geologist and of management. For such coordination to be most effective there must be a common basis of understanding as to the fundamental principles upon which the various geophysical methods are based.

Final interpretation of geophysical results is usually the responsibility of the geologist, but it is impossible for him to do justice to this assignment unless he is thoroughly familiar with the inherent physical concepts behind the data as well as the possible ambiguities and limitations associated with each method.

Summary of Geophysical Methods

In virtually all geophysical exploration for petroleum and in a large proportion of geophysical investigations for minerals, the immediate objective is to find favorable geologic **structures** rather than the pool or deposit ultimately sought. Oil occurring in structural traps such as anticlines or faults is a much more likely prospect for geophysical discovery than oil contained in stratigraphic traps. Indeed, the latter type of accumulation will generally defy geophysical detection until someone invents a successful method which measures, at the surface, some property of the oil itself. Various geochemical methods have been tried with this objective, but results thus far have been mainly negative.

All of the standard geophysical techniques involve surface measurements of significant physical proper-

ties of subsurface rocks. Systematic variations in these properties often give evidence of structures or accumulations having economic value. Such variations are referred to as **anomalies**, and these, rather than the absolute values of the physical properties, are most interesting to the geophysicist. Most geophysical interpretation is carried on with the object of determining subsurface geology by analysis of anomalies.

Gravity methods. — These are designed to detect variations in the gravitational pull of the rocks which lie as much as several miles below the earth's surface. Structural highs, such as anticlines, often involve uparching of denser rock layers that increases the local attraction of gravity on the surface directly above. A salt dome, on the other hand, composed of lighter material than the surrounding sediments, will usually give rise to a slightly smaller gravitational force on the surface than will the sediments which surround it.

Since the difference may be only of the order of 1 part or less in 10 million, it has been necessary to develop gravity instruments that measure changes less than one ten-millionth the total force of gravity. From gravity data, the geophysicist can estimate the location and magnitude of the corresponding **density** variation in the underlying rocks. Such estimates are never unique when obtained on gravity information alone, but on the basis of them locations can be singled out for further geophysical work or exploratory drilling.

Magnetic methods. — In magnetic prospecting one looks for variations in the earth's magnetic field which can be attributed to anomalous magnetic properties in relatively shallow subsurface rocks. The variations could result from changes in depth of buried magnetic rock material, from changes in its susceptibility, or from both.

Since few sedimentary rocks are appreciably magnetized, the magnetic method of prospecting will generally give information only on igneous rocks or on ore deposits with magnetic constituents. In petroleum prospecting, magnetic methods are useful where structural features on the basement surface, such as buried ridges, control overlying sedimentary structure.

Seismic methods.—These make it possible to determine the structure of rocks from variations in their elastic properties. Sound waves sent into the earth from explosions just below the surface are returned to the surface either by reflection from subsurface interfaces or by refraction along such surfaces. From the times required for the waves to reach detectors at various points along the surface, one can determine the depth and structure of the interfaces. Seismic methods give the most detailed information and also a unique picture of the subsurface in areas where characteristic formations show contrast in their elastic properties. Of all current geophysical techniques, the seismic ones are by far the most widely used.

Electrical methods. — These make use of variations in the electrical properties of rock or minerals and are so diversified that all types cannot be considered in this summary.

MILTON B. DOBRIN

THE AUTHOR

Milton B. Dobrin has been Senior Research Technologist at the Magnolia Petroleum Co. Field Research Laboratories in Dallas since 1949. He received his Ph.D. in geology (with specialization in geophysics) from Columbia University in 1950. He was with Gulf Research & Development Co. from 1937 until he joined the staff of the Naval Ordnance Laboratory in Washington in 1942. Dobrin went to Columbia in 1947 for graduate work under Maurice Ewing. He became lecturer in geology in 1948, organizing and teaching two new geophysics courses.

TABLE I—COMPARISON OF MAJOR PROSPECTING METHODS

	Gravity	Magnetic	Seismic reflection	Seismic refraction	Electrical resistivity
Instruments	Gravimeter Pendulum Torsion balance	Magnetometer (horl., vert., or total field) Dip needle	Geophone Amplifier Camera	Geophone Amplifier Camera	Electrodes Milliammeters Potentiometers
Reconnaissance or detail?	Reconnaissance	Reconnaissance	Detail	Either	Either
Quantity directly measured	Variations in force of gravity	Variations in components of earth's magnetic field or in total field	Time for reflected seismic wave to return to surface	Time for refracted seismic waves to return to surface	Current transmitted through earth between electrodes and resulting potential drop
Quantity indirectly determined from measurements	Density of rocks and depths of anomalous formations	Depth or susceptibility of basement, igneous intrusives, or ore bodies	Dip of beds Depth to distinct reflecting horizons	Depth of refracting horizons, horizontal speeds of seismic waves	Depth to interfaces, resistivities of beds
Types of structure most often located	Buried mountains, salt domes, faults	Relief of basement surface, batholiths, veins of magnetic material	Faults, anticlines, synclines, monoclines, unconformities	Faults, salt domes, basement configuration, anticlines	Ground-water surface, bedrock surface below shallow unconsolidated surface layers
Corrections	Latitude, free-air, Bouguer, terrain, isostatic	Diurnal, temperature, normal	Weathering, elevation	Weathering, elevation	
Size of crew (number of men)	5	3	12	20	2 or 3
Cost per crew—month*	$3.500-$6.000	$1.000-$2,500†	$7.000-$20.000	$9.500-$22.000	$4.000-$5.000
Unique?	No	No	Yes	Not entirely	No

*Figures are for 1949 and are taken from Jakosky's "Exploration Geophysics," 2nd ed.
†Except for air-borne work.

Electrical methods do not afford the penetration one can expect from other geophysical tools and consequently are not employed to any great extent in petroleum prospecting, where deep structures are the rule.

A widely used application of electrical methods in geophysics is electrical well logging. Here resistivities and natural potentials are measured continuously as electrodes are lowered down a drill hole. The logs thus obtained are used for correlation between wells and for other purposes. Radioactive, thermal, and other physical properties of rocks are also logged by instruments lowered into bore holes.

2. Seismic Prospecting

THE most extensively used of all geophysical prospecting techniques, the seismic reflection method comes closer to giving a direct and detailed picture of subsurface geological structure than any other geophysical method. From the data it provides one can map depths to subsurface horizons in the same way that they can be mapped from direct measurements in wells.

The depths are determined by measuring the travel times of elastic waves generated near the surface and reflected back to the surface from the formations below. The method is comparable to that employed in sounding for water depth with a supersonic fathometer, although the medium has less predictable transmission characteristics and the ultimate precision is not as great.

A unique advantage of the reflection method is that it permits mapping of many horizons from the same series of shots. The precision of the mapping is approximately the same for the deeper horizons as for the shallower ones. This is in contrast with all other geophysical methods, since in them the reliability decreases with increasing depth.

Because of their expense, reflection surveys are not ordinarily planned until cheaper but less definitive gravity, magnetic, or seismic refraction surveys, made on a reconnaissance basis, have isolated anomalous areas for detailed study by a more costly technique.

Reflection methods are most successful in areas where the oil is in structural traps, but are sometimes useful even where the traps are stratigraphic. They have been employed advantageously in most of the oil provinces of the world, although occasionally regions are encountered where near-surface conditions appear to prevent the proper reception of reflected energy at the surface. Serious difficulties of this kind have been experienced on the Edwards Plateau of West Texas.

Seismic Operations on Land

Organization of seismic crews.—The average reflection crew engaged in domestic land operations consists of from 15 to 20 men.

The **party manager** supervises the personnel of the crew and in most parties is in charge of interpretation. On some parties the interpretation is supervised by a geophysicist, who shares the top level of the organization chart with the party manager.

The **computer,** with one or two assistants, must carry on the routine work of transforming the "wiggly lines" on the reflection records into cross-sections and maps showing depths and dips. He must mark the records, read and plot times, and otherwise maintain the flow of data.

The **observer,** or operator, is in charge of the recording crew, including the shooters, the linemen, and the developer. He must maintain the electronic equipment and decide on the best shooting and detector arrangement, as well as the best instrumental settings, for getting records of optimum quality. He ordinarily operates the recording equipment in the field.

The **surveyor** and his helper lay out the shooting profiles in accordance with instructions from the party manager. They must locate and mark all shot-hole positions and detector stations. In some parties the surveyor must obtain permission from the landowner for the party to shoot on his property; in other parties this is taken care of by a **permit man.**

Each party has one or more crews for drilling the shot holes. Each crew consists of a **driller** and his helpers. The holes are drilled by a special portable rig mounted on a truck (see Fig. 1), and the drillers must maintain the equipment. For the drillers to keep up with the shooting crews, three 8-hour shifts working around the clock are often necessary.

The **linemen** lay the detectors and return them to the recording truck after each shot. They also string and connect the wires from the truck to the detectors. Sometimes they must dig handholes for burying the detectors.

The **developer** takes the record from the camera immediately after each shot and develops it so that the observer can decide whether a repeat shot is necessary and, if so, at what instrumental settings.

The **shooter,** with his helper, places the dynamite in the shot hole with loading poles and detonates the charge with a blaster when instructed over the telephone by the observer. In handling the explosives, he is responsible for the proper observance of all safety rules.

Field routine.—The surveyors precede the drillers to the area of operations, usually by a few days, and select the exact shot-hole locations, bearing in mind such factors as accessibility to heavy trucks and distance from high-tension wires. Distances and elevations must be measured with high accuracy by transit or alidade for subsequent use in reductions. The drillers, upon reaching the

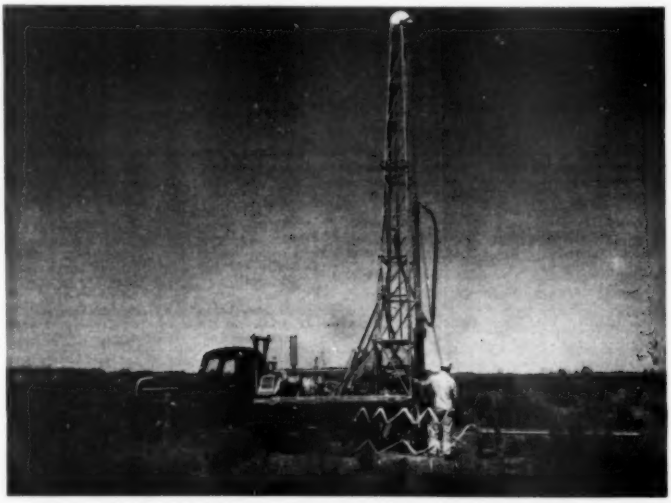

Fig. 1—Shot-hole drilling rig in operation. (Geo. E. Failing Supply Co.)

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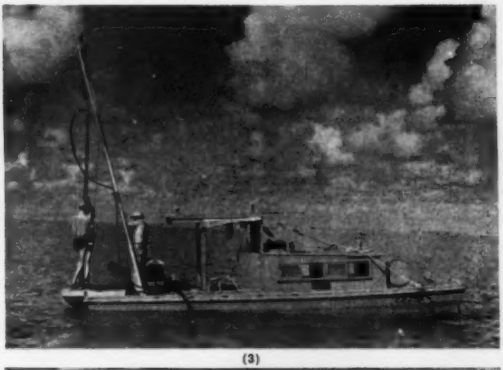

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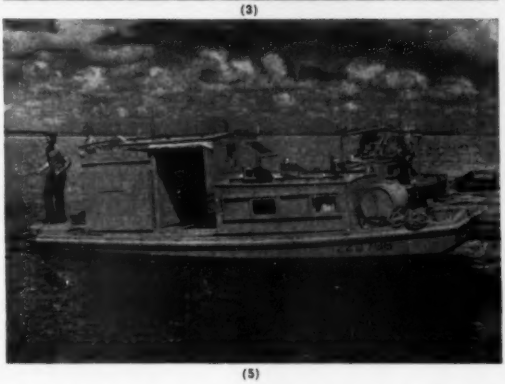

(5)

Figs. 2-5—Underwater seismic operations in shallow, protected waters. (2) Surveying in shallow water. (3) Jetting explosives into soft water bottom. (4) Shooting boat paying out firing line to shot. (5) Instrument boat; detectors being laid on water bottom. (Humble Oil & Refining Co.)

location, dig slush pits, set up the drill, and during the actual boring keep a log of all formations encountered. Shot holes are usually from 25 to 250 ft. deep, depending on the depth to consolidated rock and other local conditions.

When the shooting and recording crews reach the scene, the recording truck commonly takes its position near the middle of the detector spread. The linemen then pull cable from a reel on the truck to the detector positions, subsequently clipping or plugging the detectors to the cable. The shooters meanwhile have parked their truck a short distance from the shot hole, loaded the hole with dynamite sticks, and connected the blaster in the truck to a detonating cap buried in one of the sticks. The observer tests his detector circuit, sets the tape in his oscillograph camera in motion, and then signals the shooter to fire the charge. The signaling is done by telephone in reflection work and by radio in refraction.

When the traces have quieted down, the camera is stopped and the record, after being developed, is examined by the observer. On the basis of its indications, the amplitude and filter settings on the amplifiers as well as the charge size may be adjusted for a repeat shot with the same detector setup.

Seismic Operations in Water-Covered Areas

After the intensive fan-shooting campaign to locate salt domes along the Gulf Coast of the United States had been under way for several years, Geophysical Research Corp., working for Louisiana Land & Exploration Co., adapted its equipment for underwater work and extended its seismic operations to the lakes and shallow bays of coastal Louisiana and the Mississippi delta. The results were spectacularly successful, 11 salt domes being discovered in 9 months during late 1927 and early 1928 by only two boat-equipped crews. The techniques developed during the course of this work were later improved and put to use in extensive reflection surveys of the same water-covered areas, houseboat crews being responsible for a number of important Louisiana discoveries in the 1930's.

The most recent phase of submarine seismic exploration began at the end of World War II when both reflection and refraction surveys were inaugurated on a large scale in the offshore waters of the Gulf of Mexico and in the open Pacific off the California coast. This latest campaign is an integral part of the postwar exploration for oil reserves, previously considered inaccessible, which are believed to lie in the sedimentary formations beneath these and other shallow bodies of water.

Fan shooting over water.—Rosaire and Lester have described the operating methods used on an early fan-shooting refraction survey carried on over Vermilion Bay. Recording apparatus was mounted in fishing luggers, similar vessels being used for the shooting operations. Communication and transmission of time breaks was by two-way radio, and shot-detector distances were determined by timing the air wave and correcting for wind effects and temperature. A single detector was pushed into the

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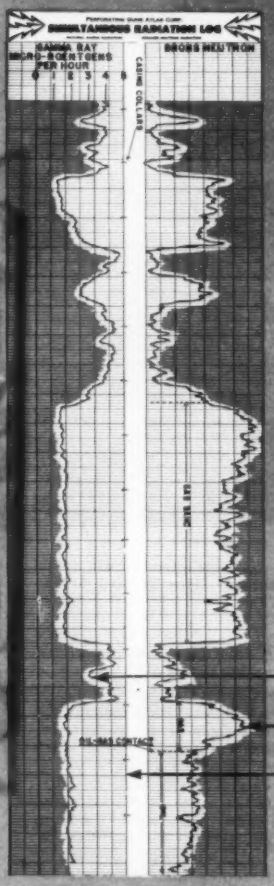

Another example of PGAC's clear definition and interpretive qualities; this interpretation was subsequently verified. This log *(below 10,000 ft.)* is an exact reproduction of the original recording. Notice the perfect absence of *"temperature drift."*

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C—a positive depth indication—by a supersensitive and accurate locator for pipe collars or flush joints

And all three of these PGAC records are made from a single instrument *on a single trip in the hole.* They are thereby *absolutely interlocked* and *automatically correlated* . . . whereas every competitive log attempting to determine similar data, must be separately recorded on at least two trips in the hole—and then must be correlated for depth relationship by superimposing and adjusting the separate recordings, with the ever-present possibility of human error.

PGAC, and only PGAC, completely eliminates such possibility of human error with its *exclusive* method of SIMULTANEOUS RADIATION LOGGING. And because all three records are simultaneously produced *on one chart,* no correlation is necessary; so the *relationship* of these phenomena by the PGAC method is automatic; positive, and absolutely accurate.

Here are FACTS you can understand

As you know, Neutron well logging is accomplished by lowering into the hole an instrument containing a Fast-Neutron source for bombarding the formation being logged, and a detector for recording the results of that bombardment. Essentially, the Fast-Neutron sources are all similar, but the detectors used are of two entirely different types.

Only Perforating Guns Atlas Corporation uses the "pure" *Neutron/Neutron* method of detection for the Neutron curve (B, above). For this purpose, PGAC uses a *Slow-Neutron* counter to detect the Slow-Neutron radiation resulting after the Fast-Neutron has bombarded and traversed the formation being logged. And because this counter will not respond to *anything* but Slow- Neutrons, the PGAC Neutron Log is a true curve *entirely unaffected* by certain detrimental Gamma Rays. These detrimental Gamma Rays are present and are recorded in all competitive methods—due to the fact that all competitive methods are dependent upon the Neutron/Gamma method of detection.

Remember, only PGAC can use the *Neutron/Neutron* method, upon which the ever-present Gamma Rays have no influence.

Neutron/Neutron VS. Neutron/Gamma Logging

All radioactivity logging *except that done by PGAC,* is dependent upon the

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use of a small ionization chamber to obtain the so-called Neutron Log (but which, actually, is a Neutron/*Gamma* Log) . . . whereas PGAC enjoys patent protection in the *exclusive use* of the afore-mentioned Slow-Neutron counter to obtain a "pure" Neutron/Neutron log.

The ionization chambers used in all competitive Neutron logging, are responsive only to Gamma Rays of various types—not to Neutrons of any type. Neutron/Gamma Logs are intended to reflect the detection of *secondary* Gamma Rays-of-capture ONLY (which result from Neutron bombardment of the formation being logged) . . . and it should be remembered that this *secondary* Gamma radiation is the only phenomenon which can be utilized by competitive methods to obtain their Neutron/Gamma logs. It is a scientific fact, however, that the logging of this one phenomenon *alone* is utterly impossible, because two other phenomena are *always* present—and these other two are decidely detrimental to obtaining an accurate Neutron curve.

The first of these two detrimental phenomena is the *natural* Gamma radiation from the formation being logged. Under normal logging conditions, this *natural* Gamma radiation may be of low magnitude and not present too much of a problem. However, many instances are known where strong *natural* radiation from the formation being logged could overshadow the vital *secondary* Gamma radiation and cause an erroneous log.

The second detrimental phenomenon is the strong, scattered, *primary* Gamma radiation which results from the Neutron source itself, simply because there is always a very strong radiation of Gamma Rays present in the bombardment source. To prevent this strong *primary* Gamma radiation from completely blocking out the *secondary* Gamma radiation — from which the log must be obtained — all competitive Neutron logging instruments are forced to use a shielding between the Neutron bombardment source and the ionization chamber obtaining the phenomenon. And right here another crux of the problem arises!

Due to the necessarily limited diameter of the logging instrument lowered into the hole, it is impossible to effect *complete* shielding between the Neutron source and the ionization chamber. Consequently, Neutron/Gamma curves recorded under all competitive methods are affected by this detrimental *primary* Gamma radiation to a greater or lesser extent, *depending upon variations in the size of the bore-hole,* as well as upon other conditions encountered therein. Therefore, and naturally enough, the Neutron/Gamma curve may lack clear definition, and the interpretation of the faulty curve may reflect conditions inconsistent with the true formation facts.

Reasons for PGAC's *Pin Point* Accuracy

Since the exclusive PGAC Slow-Neutron counter is not responsive to Gamma Rays *of any type,* no shielding against them is necessary. And since the PGAC counter is not responsive to Fast-Neutrons either, no shielding is even required against the Fast-Neutrons that may go from the bombardment source directly to the counter. With only those Neutrons which have been slowed down by traversing the formation being detected by the PGAC counter, *the reason* for the clear definition and superiority of our Neutron/Neutron curve becomes obvious.

Because of these many exclusive PGAC features, no other radioactivity log can possibly equal PGAC's SIMULTANEOUS RADIATION LOG. And remember too, only the Perforating Guns Atlas Corporation offers this proved superiority in *Accuracy, Stability, Reliability, and Economy.*

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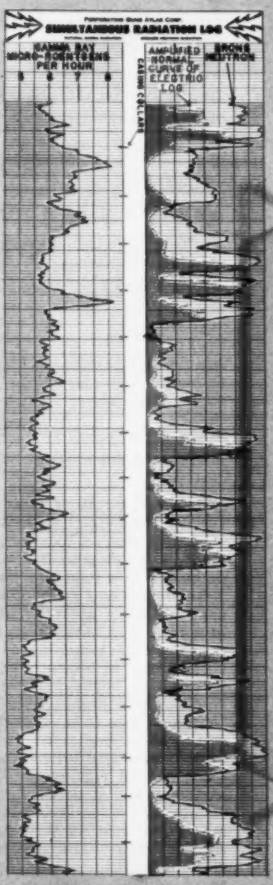
PGAC and only PGAC completely eliminates possibility of human error by its exclusive method of simultaneous radiation logging and automatic correlation.

AUTHENTICATION!

Substantiation of these *behind-the-scenes* facts may be found in the new technical volume, "Principles of Petroleum Geology," by Wm. L. Russell, Associate Professor of Geology at Texas Agricultural & Mechanical College. Any additional data you desire may be obtained without obligation by writing PGAC for answers to your specific questions.



Another example of PGAC's outstanding correlation (of a Neutron/Neutron curve with the electrical log) in an area where, previous to PGAC's Simultaneous Radiation Logging, correlation was very difficult — if not impossible.

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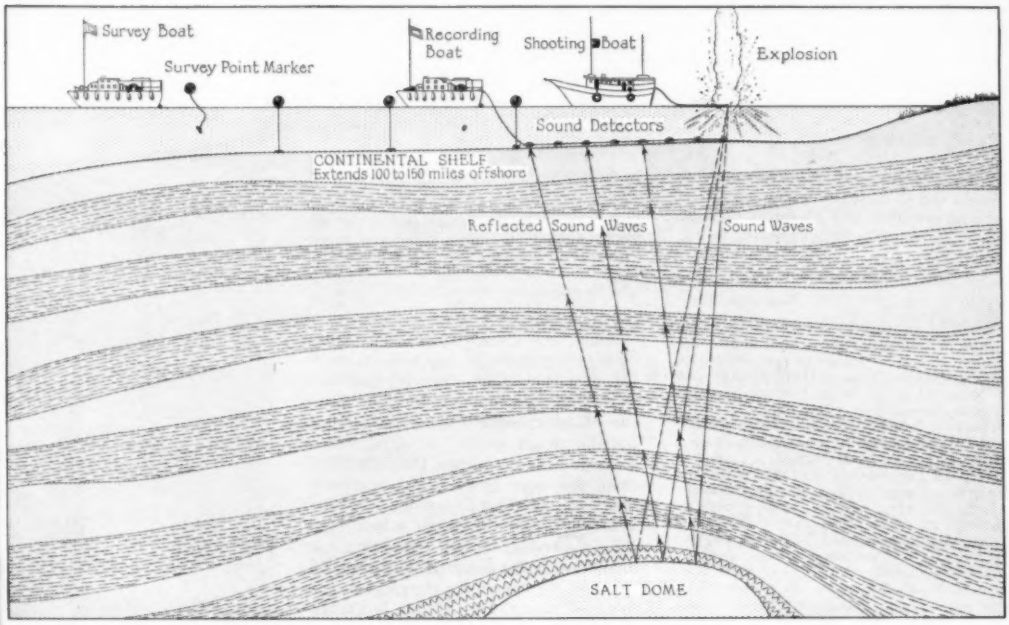

Fig. 6—Seismic reflection shooting offshore as carried on in the Gulf of Mexico. (Socony-Vacuum Oil Co., Inc.)

soft bottom with a pole at each of three recording-boat locations. The explosive charge, usually 500 to 2,000 lb., was lowered to the water bottom or buried in a hole on shore.

Shallow-water reflection.—More recent reflection operations in the shallow, protected bays, lakes, and bayous of the Gulf Coast area have been carried on in essentially the same way. Often surveying crews operate from tripods mounted in the water. In some cases (Fig. 2) their members work while immersed to the waist. Shot holes are jetted under water from special rigs mounted on boats as shown in Fig. 3. Charges are loaded into the holes and detonated from a shooting boat, of the type illustrated in Fig. 4. The instrument boat (Fig. 5) corresponds to the recording truck on land operations and contains in general the same kind of equipment. Communication is always by radio.

Offshore operations.—The earliest seismic investigation of offshore areas was carried on for purposes of academic research rather than commercial exploration. In 1935 Ewing and his associates shot their first series of refraction profiles over the Atlantic Shelf. The results have given substantial information on the constitution and configuration of the subsurface rocks below the shelf.

The extension of commercial seismic prospecting to the relatively shallow offshore waters of the Gulf of Mexico and the Pacific Shelf off California introduced new problems which led to many new operating techniques. For surveys too far from shore to be within sight of identifiable landmarks, new electronic surveying techniques developed for wartime use had to be adapted for position location. Apparatus and shooting techniques had to be developed for use in the rough seas often encountered in offshore areas.

Because of the considerable difference in water depth, distance of operations from shore, bottom composition, and legal restrictions, the technique employed off the Gulf Coast diverges in some respects from that used over the Pacific coastal shelf.

Gulf Coast operations.—In the Gulf Coast, where operations are often conducted far offshore, position location is usually by Shoran, the same radio system employed for aeromagnetic surveys, or by radar.

The over-all operation of an offshore prospecting survey in the Gulf Coast is illustrated by Fig. 6. Actually, there is wide divergence in the exact procedures of different companies working in this area.

Detectors used in deep-water work are the same in internal construction as those used on land, but their housing is modified. Usually they are mounted on gimbals to insure their being level and in proper position during shooting. The entire assemblage is fitted into a streamlined housing, which is attached to an electrical cable connecting to the shooting boat (Fig. 7). With this arrangement, the recording boat drags the entire string of detectors through the mud at the water bottom from one shooting location to another. The distances between detectors during shots is of course fixed when the cable is taut.

The explosive charges are floated just below the surface from balloons (Fig. 8), which are dropped off the shooting boat at positions previously determined by Shoran. The locations are indicated by balloon buoys, held in place by sash weights (Fig. 9), dropped into the water by the survey party. When the recording boat dragging the detectors reaches the buoy marking its station, it reverses engines to insure slack on the detector cable while the shooting boat throws off its charge at the shot buoy and moves away to a safe distance. The shot is fired (Fig. 10) with as little delay as possible to minimize drift of the detectors because of currents. Shot-detector distances are ascertained with sufficient accuracy by timing the direct explosion wave through the water.

The bottom under most of the Gulf of Mexico is sufficiently soft to permit safe dragging of the detectors. In some areas, however, coral on the bottom makes this inadvisable, and the detectors are lowered individually from the boat.

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PROBLEM and FAILURE	THE RIGHT TOOL	RESULT and SUCCESS
1. **Bakersfield, California.** Operator had spent three days trying to drill by junk at approximately 12,000 feet.	McCullough Bottom Hole Jet Cutter.	Junk eliminated, well completed without further trouble. TIME ON JOB: 4 HOURS!
2. **Lake Charles, Louisiana.** Too much cement behind 7" O.D. 23 lb. casing at around 6700' for two competitors' guns to penetrate. Operator stated this was last chance to make a well.	McCullough Glass Jet Perforator with Steel Strip Carrier. Six holes shot in two foot zone.	Production 50 B/D after perforating! TIME ON JOB: ONE HOUR!
3. **McAllen, Texas.** One string of 5½" 15 lb. casing, squeeze cemented several times, resisted attempts of two competitors' bullet and largest jet guns.	McCullough Glass Jet Perforator with Steel Strip Carrier and McCullough Burrless Bullet Perforator. 264 Burrless Bullets. 102 Glass Jet charges. Total of 306 holes shot in 51' zone at around 8000'.	Production 37 B/D after perforating. TIME ON JOB: 6 HOURS!
4. **Edmonton, Canada.** Drilling crew in attempting to set surface casing discovered several large boulders had blocked the hole. After several days trying to drill past boulders, abandoning seemed necessary.	McCullough Bottom Hole Jet Cutter.	Three boulders were eliminated at 21', 32', and 55'. TIME ON JOB: 3 HOURS!
5. **Ventura, California.** The 4½" drill pipe was stuck in this 8,000' well. Oil Operator spotted oil around the drill collars for several days without results.	McCullough Magna-Tector.	Free point was located at 400' above the drill collars. Oil was spotted at that point and pipe came loose in TWO HOURS!
6. **Odessa, Texas.** This 12,000' well with one string of 5½" casing, cemented, could not be penetrated by several competitors' guns.	McCullough Glass Jet Perforator with Steel Strip Carrier. 180 holes shot.	Production 1300 B/D after perforating! TIME ON JOB: 8 HOURS!

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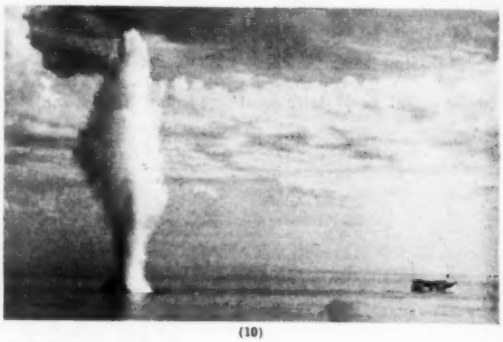

(10)

(8)

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Figs. 7-10—Views of deep-water seismic operations in Gulf of Mexico. (7) Letting out detector cable. Each detector is in waterproof housing (shown on roller) and is mounted on gimbals. (8) Dropping charge into water from shooting boat. Dynamite sticks are floated from balloon. (9) Preparing balloons for marking survey locations. (10) Geyser from explosion of charge detonated just below water surface. Shooting boat at right. (Socony-Vacuum Oil Co., Inc.)

Operations off California. — The marginal waters of the Pacific Coast from San Luis Obispo, Calif., to the Mexican border have been systematically explored in an offshore seismic survey sponsored by a pool of 17 oil companies. Position location here should be much simpler than in the Gulf, since the 600-ft. contour is usually reached less than 5 miles from shore and the mountains and cliffs along shore give numerous landmarks for visual surveying by sextant and three-arm protractor. Frequent fogs, however, make Shoran advisable.

Because of the greater water depth and the hard bottom, it is impractical to drag the detectors along the ocean floor; instead they are attached to platforms suspended about 15 ft. below the surface of the water and weighted so as to float horizontally. The platforms hang from a 2¼-in. steel cable to which the wires from the instruments are attached.

Three boats have been used in the California operations. The instrument boat pulls the line of detectors which is attached at the other end to the tail or anchor boat. The latter keeps the steel line taut and within a few feet of the surface. The third vessel is the shooting boat, which detonates the charges suspended from balloons in the same way as in the Gulf Coast. The detector lines are normally from 500 to 1,000 ft. long with 50 to 100-ft. detector spacing. Where dips are steep, profiles are shot at right angles also.

Because of local conservation regulations, all charges in water less than 100 ft. deep must be buried in the sea bottom before being fired. The shot holes are jetted from the boat. Water flowing under pressure through small-diameter pipe makes an opening in the bottom. The charge is released in the opening before the pipe is pulled up.

In spite of these operational complexities, offshore seismic work off both the Gulf Coast and California has turned out to be faster than land work and gives seismic records which are generally better than those shot on adjacent land areas. This is because of favorable bottom conditions, the elimination of shot-hole drilling, and the easy mobility of the shooting and recording units. In the California surveys, 75 shots were fired on an average day, the record through 1949 being 332 shots.

Reflection Records

When dynamite is exploded in a shot hole, the waves recorded by nearby detecting instruments will have taken a great variety of paths, each requiring a different time to travel from shot to detector. For several seconds after the first arrival of energy at the detector, the ground below it will be in continual motion under the impact of waves that have traveled along the various paths. Some waves will have been refracted and others scattered; some waves will have traveled along the earth's surface, and others will have been reflected upward from various interfaces.

To use the reflected energy on the record, one must distinguish it from ground motion due to other kinds of waves. It is not likely that this could be done if only a single detector were used. In actual practice, however, a number of detectors laid out with close spacing along a line pointing to the shot is used to receive the waves from each explosion.

The ground movement at each instrument is recorded on a separate trace of the same record. The waves corresponding to a reflection will all line up across the record in such a way that the crests or troughs on ad-

These 4 Hazards make Baash-Ross DRILL COLLAR SLIPS "MUST" safety protection

1 The constant change of drill collar diameter caused by wear and abrasion against the fresh-cut walls of the hole.

2 The usual flush design with no shoulders for stopping a slipping drill collar.

3 The drill collar's hard heat-treated surface that reduces gripping efficiency.

4 The relatively low drill string weight available for wedging the slips into the bowl.

Baash-Ross Drill Collar Slips showing extensions that provide seat for a Baash-Ross Safety Clamp

. . . And *Every* Drill Collar from 3" to 8¼" can have this vital protection!

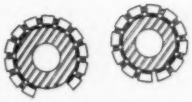
That's why safety-minded operators throughout the world have adopted Baash-Ross Drill Collar Slips as "must have" rig equipment, because these Slips are *specially designed* to overcome the risks of supporting a drill string in the rotary table. In contrast to the normal fixed-curvature design of rotary slips, the unique multi-segment design of Baash-Ross Drill Collar Slips permits them to w-r-a-p around the drill collar like a chain tong. They take a full slip-proof grip whether the drill collar is new or worn, round or out-of-round. *And they automatically compensate for as much as 1½" change in drill collar diameter—more than ample for modern drilling operations.*

For example, note in the table how a Baash-Ross Drill Collar Slip that fits a 7" diameter drill collar will also fit *any* diameter down to 5½". Adjustment for wear is automatic and continuous throughout the working range!

This means that Baash-Ross Drill Collar Slips automatically take a *full* grip on any drill collar within their range—a grip that gives adequate support to compensate for the continuous wear which changes drill collar diameters . . . for the hard heat-treated surface . . . and for the lack of drill string weight.

The "Why" of Baash-Ross Drill Collar Slips

ORDINARY SLIPS that fit the drill collar when new (A) are unable to adjust themselves to smaller diameters as the drill collar wears away. Result, grip becomes less and less adequate (B) and risk of a costly fishing job constantly greater.



BAASH-ROSS DRILL COLLAR SLIPS consist of many narrow slip segments flexibly linked together. Result—they w-r-a-p around the drill collar and always take the same full grip whether drill collar is new or worn, round or out-of-round.

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To insure long life, minimum maintenance and maximum gripping efficiency at all times, the liners in Baash-Ross Drill Collar Slips can be readily renewed by simply pulling a stainless steel pin, sliding out the worn liner, inserting a new liner and replacing the pin. It's simple, quick and inexpensive!

Sizes and Operating Ranges of Baash-Ross Drill Collar Slips		
SIZE	Operating Range From	To
A	3"	4½"
B	3¾"	5¼"
C	4¼"	5¾"
D	5½"	7"
E	6¾"	8¼"

FOR DOUBLE SAFETY

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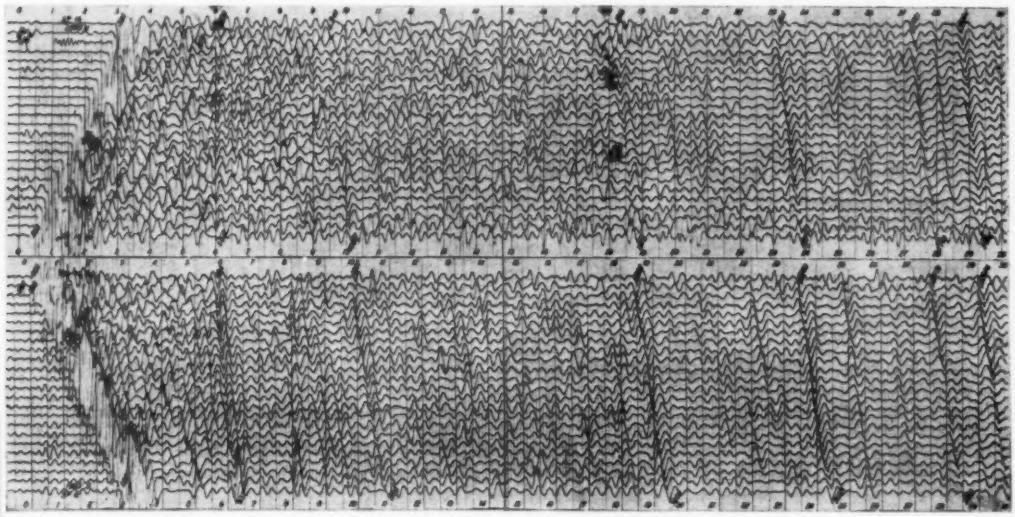

Fig. 11—Pair of reflection records from detector spreads on opposite sides of same shot hole. Numbers of vertical lines represent time after explosion in tenths of a second. (National Geophysical Co., Geophysics, 1947.)

jacent traces will give the appearance of fitting into one another. This lining up may only be observable from a single wave cycle on each trace but often it persists for two or three successive cycles. The time differential in arrivals of a given peak or trough at successive detector positions (the "stepout time") gives information on the dip of the reflecting bed while the absolute time indicates its depth below the surface.

Sample records.—Fig. 11 shows a sample pair of reflection records. Each record has 24 traces, which indicate the approximate ground motion beneath respective detectors in a group of 24 laid out about 85 ft. apart along a profile.

The upper record represents the detector spread extending northward from the shot; the lower one represents spread extending to the south.

Fig. 12 shows the setup schematically and illustrates the paths taken by waves reflected from two of the reflecting horizons to the nearest and farthest detectors of each spread. Wave paths to detectors between the third and the twenty-second in each group of 24 are, for simplicity, omitted from the diagram.

Let us examine some of the events on these sample records. The instant of the explosion corresponds to the zero points of the time scales marked on the records. For a short interval following the shot, the traces are quiescent, but at times ranging from 0.04 second, for the nearest detector, to 0.30 second for the farthest, the traces kick down sharply.

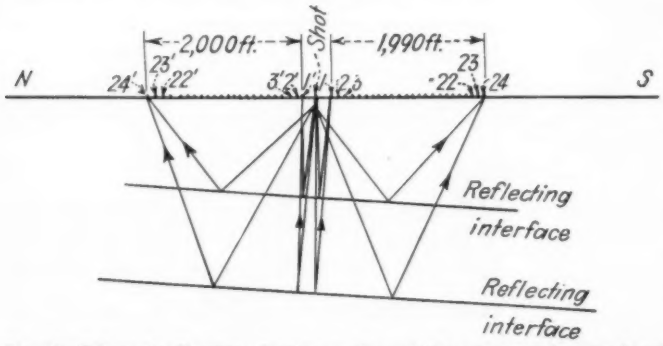

Fig. 12—Schematic diagram of setup used to obtain two records reproduced in Fig. 11. Numbers along surface represent trace numbers (read from the shot point) corresponding to labeled detectors.

These first arrivals are waves refracted upward from the first high-speed zone below the weathered layer. Their times can be plotted against the shot-detector distance to obtain the weathering thickness by two-layer refraction methods.

At about 0.6 second, one observes the first reflection that can be readily followed across the entire lower record; at 2.4 seconds, the first reflection to correlate all the way across both records comes in. The latter reflection is measured on the northernmost detector of the double spread at about 2.32 seconds and on the southernmost one at about 2.48 seconds. Since both detectors are about the same horizontal distance from the shot, it is evident that there is substantial dip to the south at this depth.

Correlation.—It is often possible to follow the same reflection over a distance much greater than that covered by a detector spread for a single record. In such cases, one places records from adjacent spreads edge to edge and correlates the reflection from the last trace of one record to the first of the next in the same way as one follows a reflection from one trace to the next on the same record. Such correlation can be continued indefinitely on successive records shot in proper proximity if the reflections persist, as is illustrated in Fig. 13.

Where there are no gaps between adjacent detector spreads, the technique is called **continuous profiling.** Often a particular reflection will have a unique character which persists over a long distance and which can be correlated across gaps in the profile where no detectors were placed. Even

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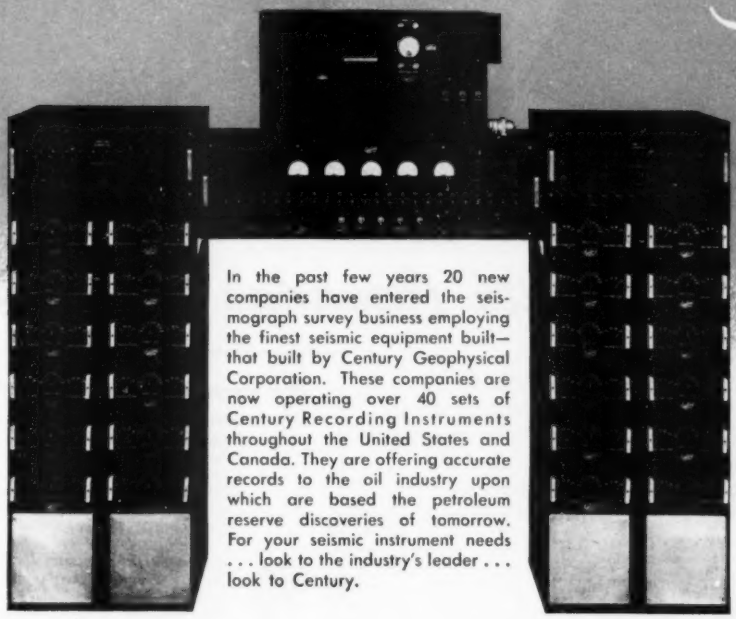

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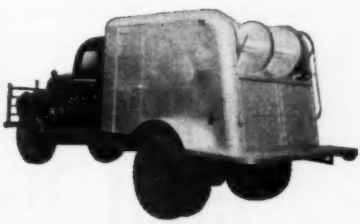

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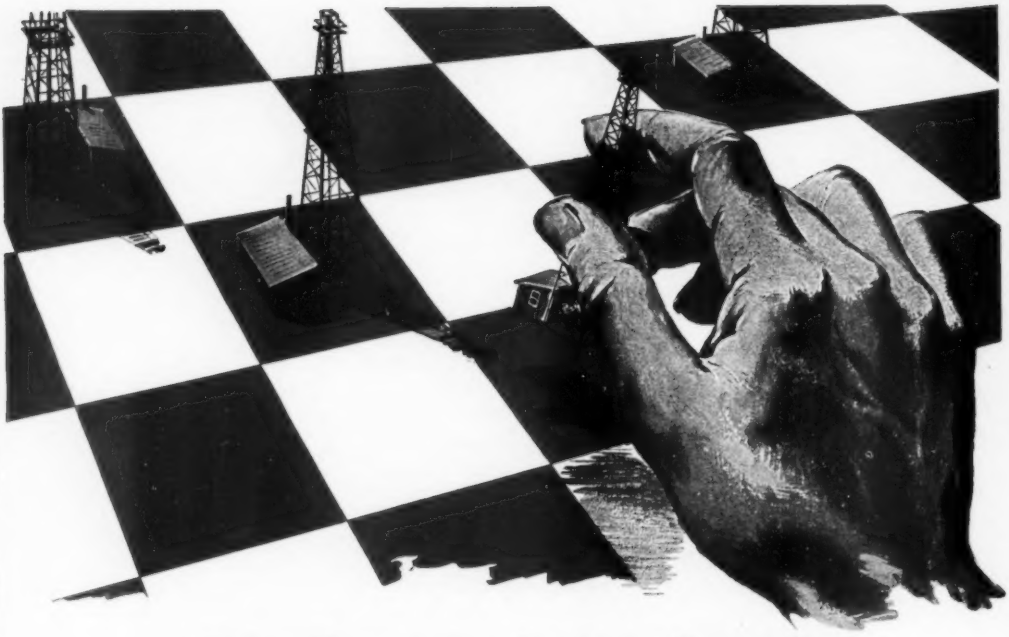

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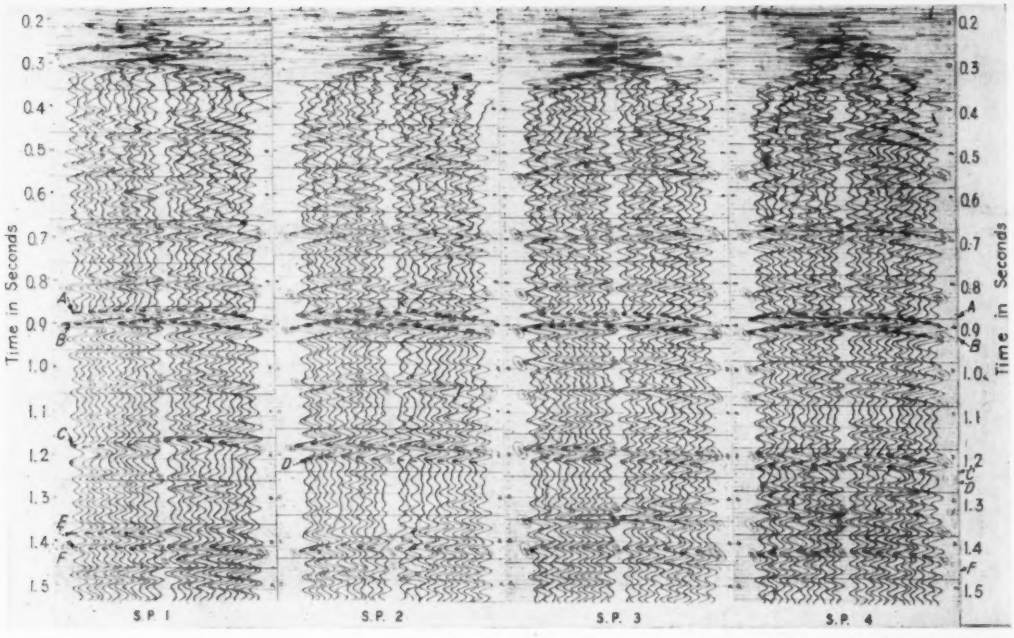


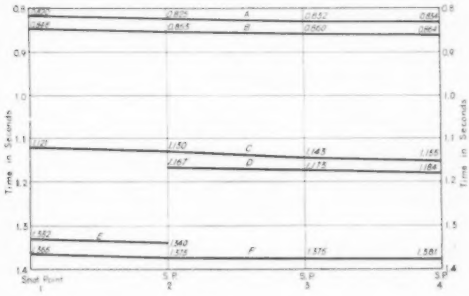


Fig. 13—Records for group of four adjacent split spreads and plot of reflection time segments corresponding to several typical reflections (A to F) marked on the records. Discrepancies between times on records and those on plot result from corrections. (Seismograph Service Corp.)

where the character of the reflections is not particularly distinctive, one can often correlate reliably across a gap if the time intervals between corresponding reflections remain substantially same for records on both sides.

Correlation of reflections is not always as simple as it might appear at first glance. Often a reflection which was characterized by a single trough evolves into two troughs as one moves from one trace to the next; there may then be considerable question as to which of the two "split-off" features is the continuation of the one originally followed.

A wrong correlation might lead to a reversal of the direction of dip as well as to misclosure around the loop. Such phase splitting could be caused either by changes in the character of the reflecting surface or by variations in the geologic section anywhere above the reflecting interface.

Choice of Shooting Procedures

The disposition of shots and detectors in reflection shooting depends on a large number of factors. Among these are time, expense permitted per mile of coverage, accessibility of the terrain, subsurface geology, and character of the reflections.

Correlation shooting and dip shooting.—In some cases it is possible to obtain reflections from identified or unidentified geological markers which persist over a wide area. It is then desirable to correlate such reflections along all shooting profiles in the area and to map the depths to these markers in the same way that one would contour a subsurface formation from well data. Records to be handled in this way are obtained by **correlation shooting.** Occasionally, the reflection from a particular formation will have a distinctive character which enables one to recognize its origin wherever it appears on the record.

The Heterostegina limestone of the Gulf Coast is such a formation. Continuity of control is not so important here because one can correlate by character across any gaps in the profile. More usually, however, mapping by correlation requires that there be no substantial gaps in depth control over the area being mapped. The last detector of one spread should not be any farther from the first of the next than the separation between adjacent detectors on the same spread.

More suitable for reconnaissance, **dip shooting** involves the calculation and mapping of dips at all shot points. Continuous control is not necessary, since correlation need only be across a pair of records from adjacent spreads shot in opposite directions. The results are often indicated on the map as scattered dip vectors which can be contoured in the same manner as the arrows representing gradients on torsion-balance maps. In areas of consistent regional dip, any reversal of regional would be sufficient to earmark a location for more intensive seismic exploration, and dip shooting is particularly useful for reconnaissance.

Correlation shooting gives the maximum accuracy and maximum detail but at the highest cost. It is the only practical method for locating structures of small relief or areal extent. Dip shooting is faster and cheaper but is to be recommended only where regional geology is well known.

Depth points.—When the depth to

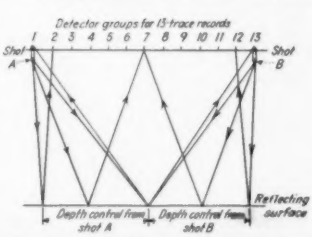
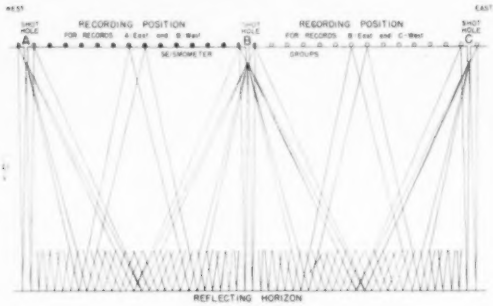

Detector groups for 13-trace records
1 2 3 4 5 6 7 8 9 10 11 12 13
Shot A
Shot B
Depth control from shot A
Depth control from shot B
Reflecting surface

Fig. 14—Obtaining continuous depth control along profile by recording shots from opposite directions with same detector spread.



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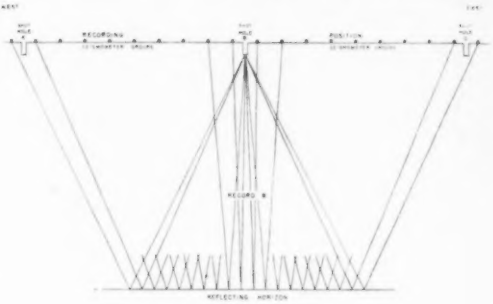

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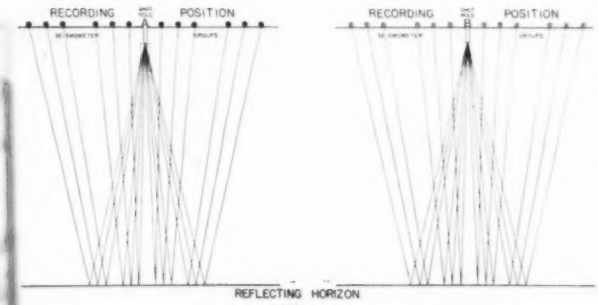

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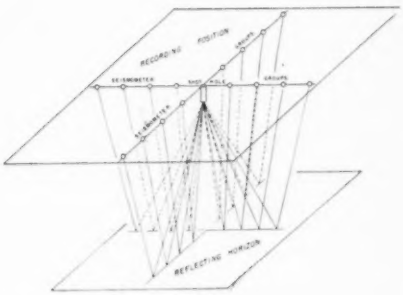


(18)

Figs. 15-18—Four spread arrangements in common use. (15) Continuous correlation with standard spreads for 16-trace recording equipment. (16) Continuous correlation with split spread for 20-trace equipment. Detectors receive waves from shot hole B only. (17) Jump correlation for 12-trace equipment. Distance between shot holes may be a mile. (18) Four-directional dip control for 16-trace equipment. (Geophysical Service, Inc.)

a horizontal interface is calculated from reflection times, its value should be plotted not at the shot or the detector position but at the point midway between the two, since the wave is actually reflected from the interface at the midway position. If continuous depth control is desired along a profile, the detectors must be uniformly spaced between adjacent shot points and each detector must in turn receive reflections from shots on opposite sides of the spread. The shot from each side of the group gives depth data covering the half of the spread nearest it, as shown in Fig. 14. When the bed is inclined, the depth point will of course be displaced from midposition, but it is customary to correct for the error at a later stage of the interpretation.

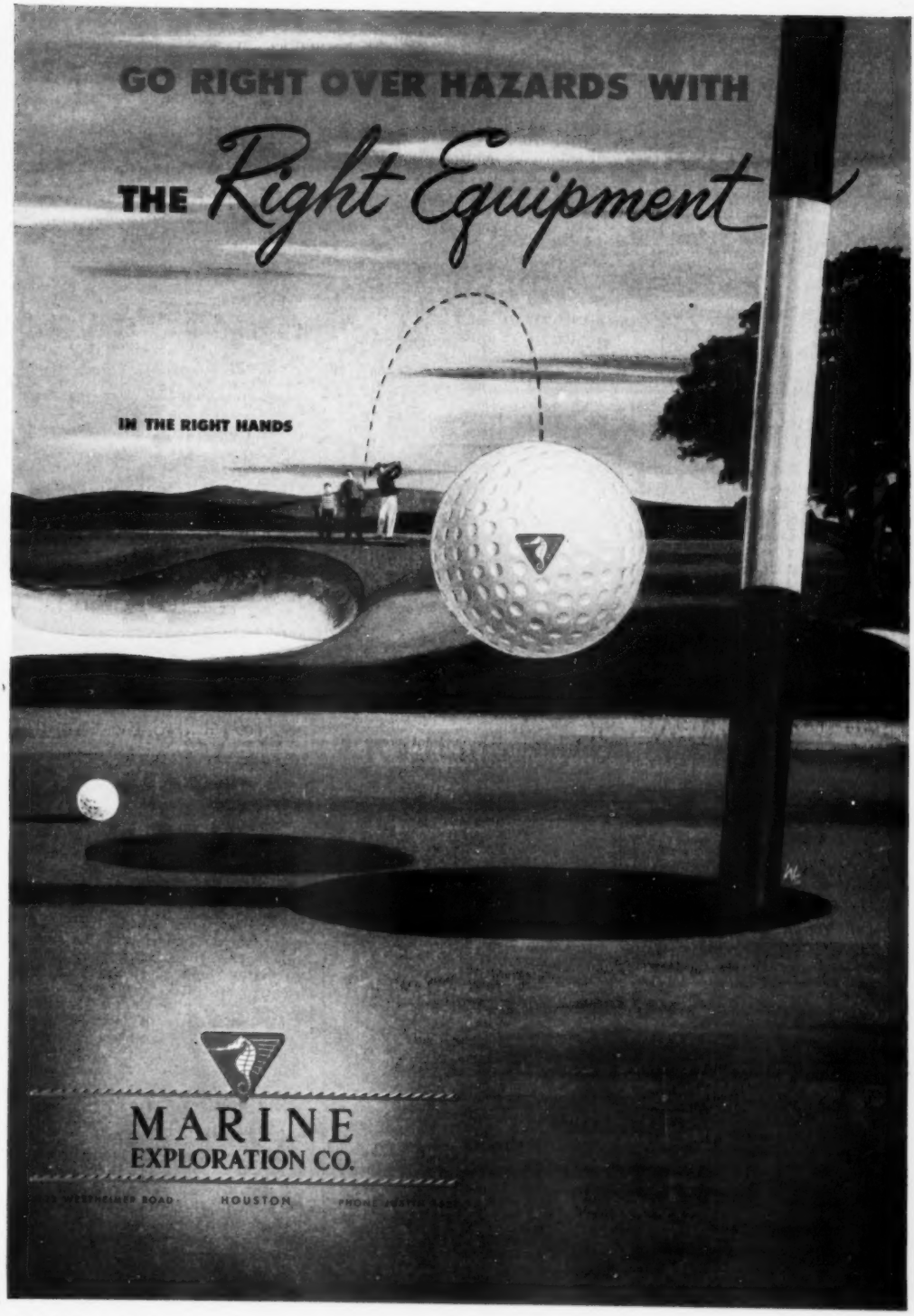
Shot-detector layouts. — Although shooting arrangements vary considerably among companies, they are usually laid out with one of three purposes in view: (1) continuous coverage, (2) jump correlation, or (3) dip mapping.

Continuous coverage.—Figs. 15 and 16 show two common arrangements for continuous correlation, the standard spread and the split spread. In the standard-spread layout, records are made from detector groups entirely or almost entirely on one side of the shot point. In Fig. 15, the two records "A-East" and "B-West" are, respectively, from successive shots at A and B, which are received in turn by the detectors lying between these two points. The records "B-East" and "C-West" are made in a similar manner. This arrangement provides continuous depth control of the kind given by the setup illustrated in Fig. 14.

The "split spread" (Fig. 16) involves an equal number of detectors on each side of the shot hole; all of them are represented by traces on the same record. The depth control here is equally distributed on opposite sides of the shot. All 20 detectors between shot hole A and shot hole C record the shot from B simultaneously. Extension of continuous control to the west would require a group of 20 detectors centered at hole A, while an extension to the east would require a group of the same kind centered at hole C. Split spreads are less expensive because fewer shots are necessary to cover a given distance along the profile.

Jump correlation. — Where the reflecting horizons give characteristic reflections that persist over a large area, it is most economical to shoot for "jump correlations" across gaps in the depth control. Fig. 17 shows a typical spread arrangement used in this type of shooting. Two shot holes a mile apart are each at the center of a split spread. The detector groups (four detectors, 20 ft. apart) are themselves in groups of three with centers separated 500 ft. This arrangement is usually used only for reconnaissance.

Dip shooting.—In shooting for dip control only, it is necessary to have detector spreads extending from the shot points at right angles to one another so that the true dip in space can be calculated from mutually perpendicular components. Fig. 18 shows a layout by which dip information at the shot point can be obtained from a single shot giving a single 16-trace record. This record would contain reflections from two mutually perpendicular split spreads with four detector groups in each of four directions from the shot. The more usual arrangement is to set up special "cross spreads" perpendicular to the profile at each three or four shot points on the profile. At the other end of each cross spread, a supplementary shot would be needed for two-way control on dips in the vertical plane perpendicular to the profile.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Magnetic Prospecting

THE field methods and interpretation procedures used in magnetic prospecting on land depend primarily on the type of instrument used and the purpose of the survey. We shall limit our discussion to surveys using the Schmidt-type vertical magnetometer. Although this instrument has been a standard tool in reconnaissance prospecting for petroleum, it is likely that the airborne magnetometer, because of its speed and economy, will largely supersede it in the search for oil.

In petroleum exploration, the magnetometer can often locate sedimentary oil traps by picking up anomalies in the earth's magnetic field caused by underlying basement structures. Buried hills, anticlines, and faults in igneous or metamorphic rocks are often reflected in the structure of overlying oil-bearing formations.

TABLE 2—SAMPLE REDUCTION CALCULATION

	Station					
	Base	1	2	3	4	Base
Time	9:00	10:00	11:30	1:15	2:30	3:00
Temp. T	16	19	21	23	22	20
E. rdg.	5.1	6.9	7.6	9.0	9.5	5.8
W. rdg.	5.4	6.7	7.2	8.7	9.7	5.8
Avg. A	5.2	6.8	7.4	8.9	9.6	5.8
kA	84	110	120	144	156	94
a(10 — T)	—4	—6	—8	—9	—8	—7
Diurnal Var.	—15	—22	—40	—25	—12	—6
Regional	—316	—328	—340	—352	—364	—316
Base corr.	545	545	545	545	545	545
Z, gammas	294	299	277	303	315	310
Inst. closure error	0	—3	—8	—11	—14	—16
Adjusted Z	294	296	269	292	301	294

Schmidt-Type Magnetic Field Balance

The Schmidt-type magnetic field balance is by far the most commonly used magnetic instrument for prospecting on land. In principle, it consists of a magnet pivoted near but not at its center of mass, so that the magnetic field of the earth creates a torque around the pivot that is opposed by the torque of the gravitational pull upon the center. The angle at which equilibrium is reached depends on the strength of the field. To attain high sensitivity a great deal of precision work is required in the design and construction of the mechanical and optical systems. The principle, however, is intrinsically simple.

Schmidt-type magnetometers, like dip needles, do not measure absolute fields, but they respond to small changes in field components with an accuracy as great as 1 gamma under favorable conditions. Separate models are available for measuring vertical and horizontal fields.

Vertical balance.—The operation of the vertical balance is illustrated schematically in Fig. 19. Assume an approximately horizontal magnet oriented perpendicular to the magnetic meridian so that the horizontal component of the earth's field exerts no effect. The magnet is balanced on a knife-edge displaced from the center of gravity C a horizontal distance d and a vertical distance a. The vertical magnetic field of the earth, acting on the poles as shown, tends to cause counterclockwise rotation, and the gravitational force, clockwise rotation. The position of equilibrium is indicated on a graduated scale by a light beam reflected from a mirror attached to the magnet. If the vertical field changes, as it might at a different location, the position of equilibrium shifts and the difference in scale readings gives a measure of the difference in the vertical fields.

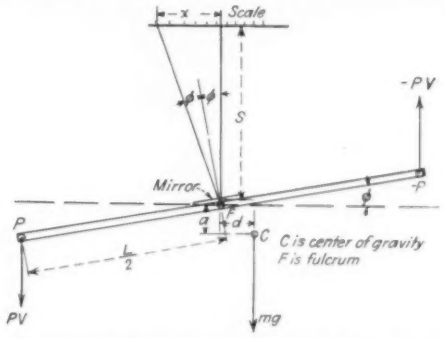

Fig. 19—Principle of Schmidt-type vertical magnetometer.

Field Procedures

In reconnaissance magnetic surveys for petroleum, stations are usually spaced about a mile apart; in sectionized parts of the United States, they are placed at section corners. Stations should be set up at safe distances from all iron objects that might interfere with the normal field.

If a single instrument is used on the survey, a base station is chosen at the beginning of the day's work and a schedule is arranged that will permit a return reading there after every few stations in the field are occupied. The procedure is much like that employed in gravity prospecting, differences being picked off a daily variation curve comparable to the drift curve used in gravity work.

A more satisfactory method of eliminating diurnal variation, however, is to use two instruments, a base-station magnetometer and a field magnetometer. This way it is only necessary to return the field magnetometer to the base for checking at the end of the day, since the base magnetometer is adapted for continuous recording of the variation at the base station.

Any difference between relative readings of the two instruments at the beginning and end of the day is attributed to variations in the properties of one or both of the magnetometers. This error is due usually to transportation of the field instrument and is corrected, if not too large, by distributing the difference among the stations occupied during the day.

In standard magnetometer operations, it is good practice to occupy two sites about 50 ft. apart at each location. To insure against local disturbances, four readings are made at each station, two of them with the north end of the magnetometer magnet pointing east and two with the north end west. Extreme care must be exercised in the leveling and orienting of the instrument.

Reduction of Magnetic Data

Before magnetic readings can be mapped, several corrections must be applied. These are the temperature correction, the diurnal correction, and the normal correction. A terrain correction may be desirable under special conditions.

Sample reduction. — The reduction procedure can be best illustrated by

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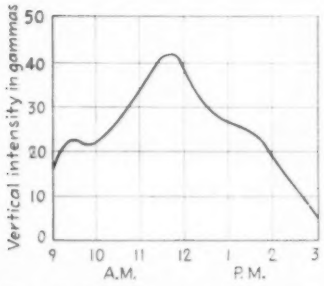


Fig. 20—Diurnal variation curve for sample computation.

a calculation sheet (Table 2) of the type used in an actual survey. The instrument has a sensitivity k of 16.2 gammas/scale division and a temperature coefficient α of 0.7 per degree Centigrade. Standard temperature is 10° C.

The diurnal variation curve obtained by the second instrument at the field station is shown in Fig. 20. The regional correction is taken from USC & GS contour maps of vertical magnetic intensity.

The base correction is simply the value of vertical magnetic field strength established at the base station by ties with a preexisting net. The adjustment for instrumental closure is necessary, since the value of Z must of course always be the same at the base station, and any difference between values for successive occupations must be considered as a closure error and distributed, as shown, among all observations within the loop.

Interpretation of Magnetic Data

After the reduced magnetic readings are plotted on maps and contoured, the techniques of interpretation are much like those employed in gravitational prospecting. Most magnetic interpretation involves only qualitative examination of the contour maps. In areas of sedimentary surface rocks, such maps often indicate the structure of the top surface of the igneous basement. Major structural trends in the Wichita Mountain area of Oklahoma are delineated very clearly on the magnetic map of the region, as shown in Fig. 21. Here the magnetic trend conspicuously follows the northwest-southeast trend of the Arbuckle-Wichita axis, which is well expressed in both the topography and surface geology of the area.

Even in qualitative interpretations it is necessary to bear in mind that an anomaly may signify either relief in the basement surface or variation in the susceptibility. Changes of polarization in basement rocks buried a mile or more may give rise to anomalies as high as several thousand gammas. At the same depth, structural features of the type important in oil prospecting would seldom produce anomalies much larger than 50 gammas. Fig. 22 illustrates why anomalies due to polarization are larger. The vertical field above a semi-infinite slab of magnetic material is $2\pi I$ regardless of the depth of the top surface. A lateral change from granite ($k = 0.003$) to andesite ($k = 0.013$) in a polarizing field H of 0.5 oersted would give rise to a change in I (which is kH) of 0.005 centimeter-gram-second units (c.g.s.). The maximum change in field corresponding to this would be $2\pi \times 0.005$ c.g.s., or about 3,000 gammas.

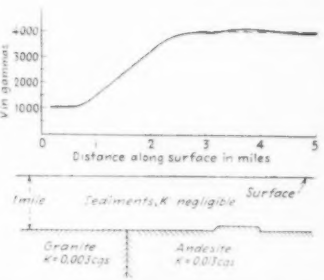


Fig. 22—Comparison of magnetic effect of lateral susceptibility change in basement with effect of structural feature on basement surface.

A boss 1,000 ft. high and 1,000 ft. in diameter on an otherwise flat andesite surface covered by 5,000 ft. of nonmagnetic sediments would cause a surface anomaly of only about 120 gammas. This example indicates how deep-seated susceptibility changes can cause anomalies of no structural significance which are much larger than those resulting from unusually high relief in the basement topography.

A qualitative indication of the depth to the source of a magnetic anomaly is the sharpness of the anomaly itself. In general, the broader the feature on the magnetic map or profile, the deeper is the source. This principle is often invoked in eliminating the effect of shallow magnetized material in petroleum surveys where only deep basement features are of interest.

Any inclination in the magnetic axis of a buried mass may be indicated qualitatively by a lack of symmetry in the magnetic profile or contours, although the same asymmetry may result from irregularity in shape. In the case of the vertically polarized buried sphere, there will be an area

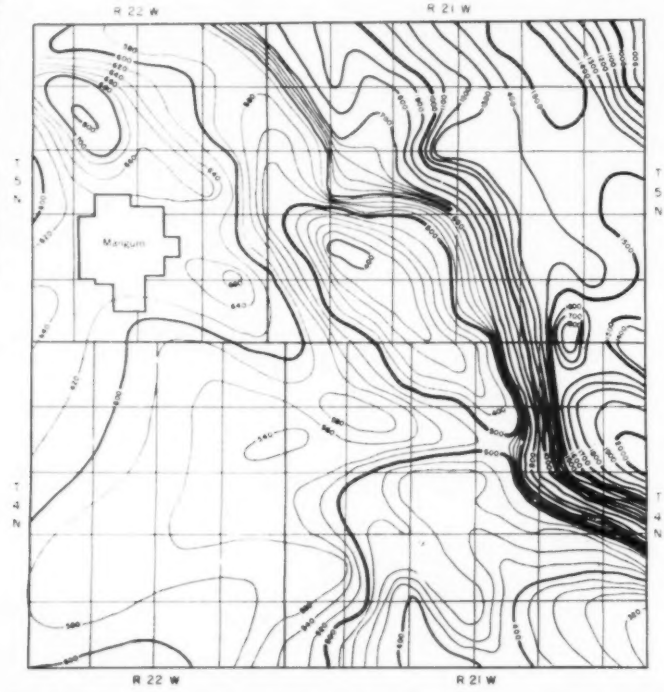
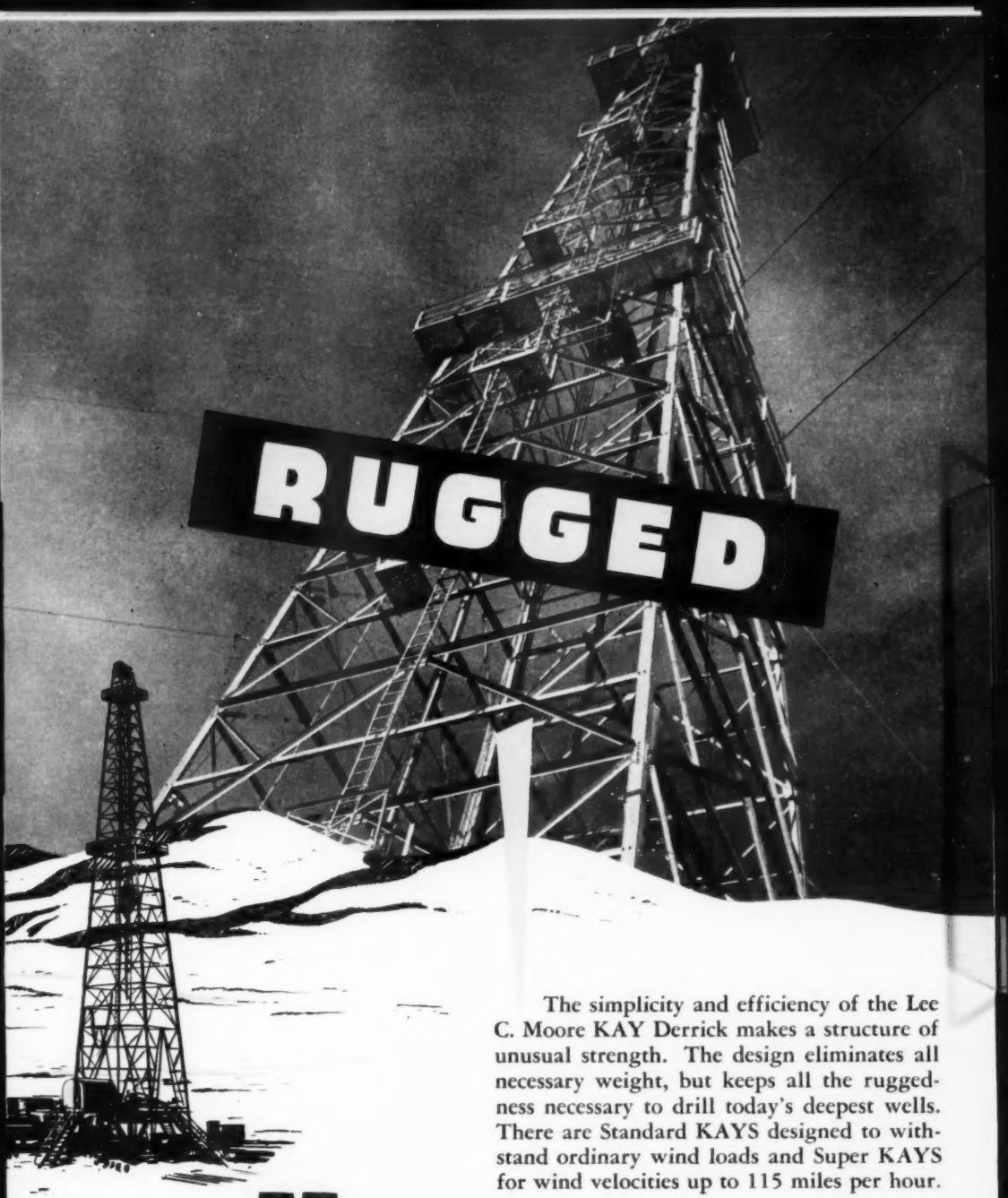


Fig. 21—Vertical magnetic intensity in neighborhood of Mangum, Okla. (U. S. Geological Survey).



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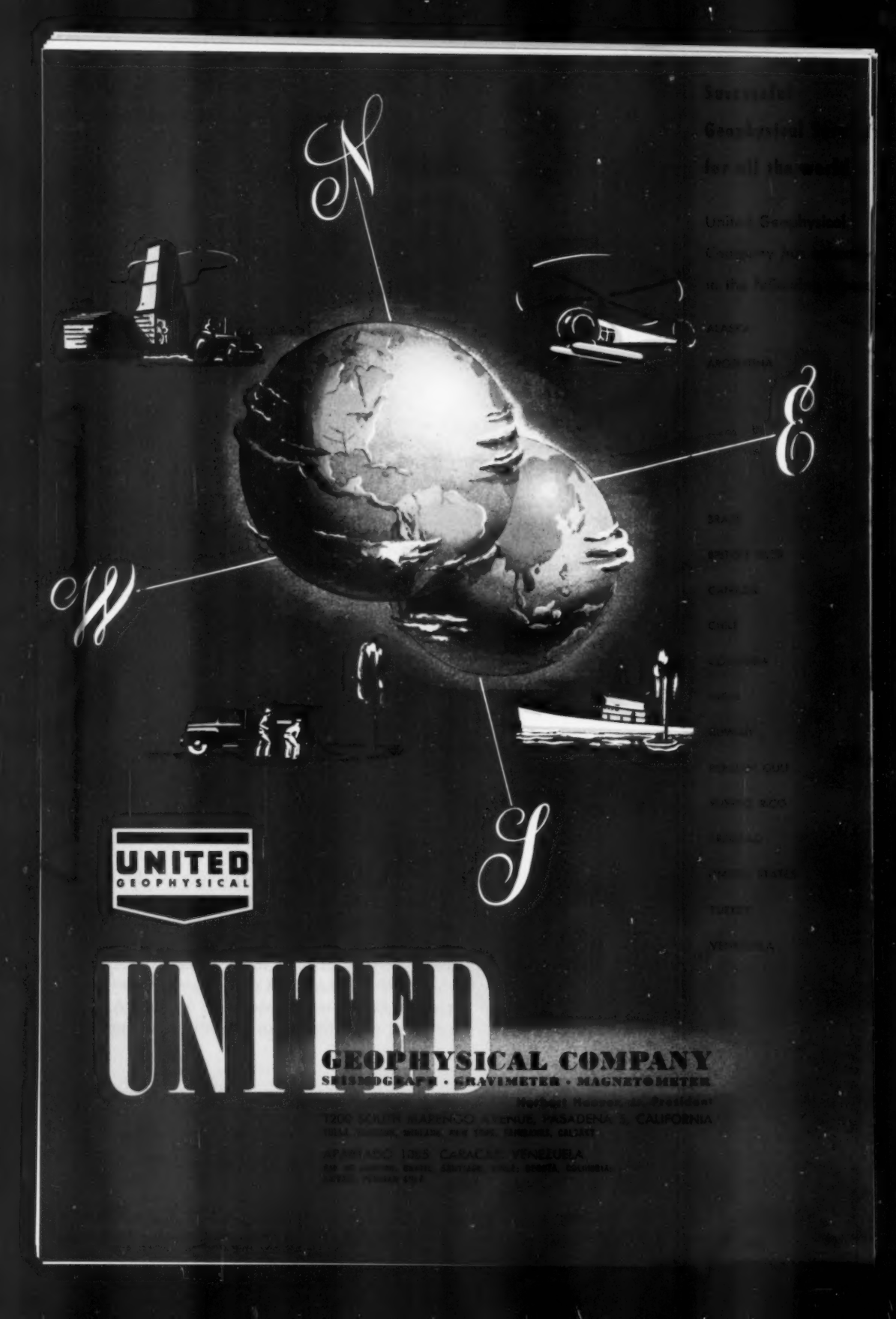

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of negative intensity (a magnetic low) symmetrically surrounding the central positive high. If, however, the magnetic axis is inclined, the magnetic low may be observed only on one side of the center.

Quantitative techniques.—Quantitative analysis of magnetic data is generally difficult on account of possible variations in susceptibility as well as the uncertainty which often exists as to the direction of the rocks' polarization, an uncertainty usually caused by a lack of information on the relative proportion of induced and permanent magnetization. There are many instances, however, where susceptibilities are known and where it is fairly safe to assume that the magnetization is in the direction of the earth's field. In such cases it can be quite instructive to calculate the probable depths and shapes of the rock bodies giving rise to the observed anomalies.

Limitations of magnetic data. — All the statements made on the ambiguity of gravity data (see section on "Gravity Prospecting") hold equally well for magnetic data. The same laws of potential theory that tell us why gravity data can never be accounted for by a single, unique interpretation apply also to the magnetic case. Here again independent geological information is necessary if the interpreter is to choose the most reasonable of an indefinite number of subsurface pictures that might fit the magnetic observations equally well. Just as it was often impossible to differentiate between structure and density change as the source of a gravity anomaly, it is equally impossible in many cases to specify whether an observed magnetic anomaly results from structural relief at the top of the basement rock or from a lateral change in the rock's susceptibility. For this reason, magnetic surveys are seldom reliable in themselves unless there is independent control from other sources.

Even when concentrations of magnetic material are accurately detailed by magnetic methods, it is not always possible to evaluate their economic possibilities without considerable further investigation. There is often such wide divergence in the susceptibility of various magnetic minerals that very small quantities of one may have more effect than very large quantities of another.

Petroleum prospecting.—In some instances sedimentary formations have a high enough concentration of magnetic minerals that their structure can be outlined by magnetic surveys.

Peters has tabulated data on 19 oil and gas fields in the United States which were discovered either entirely or in large part through magnetometer surveys. The majority of these, along the Balcones fault zone in Texas, have their production in highly magnetic serpentine plugs with the proper porosity to serve as oil traps. Fig. 23 shows the magnetic anomaly observed over such a serpentine plug in South Central Texas.

A more usual type of relationship between magnetic anomalies and petroleum occurrence is encountered when a sedimentary oil trap reflects structural features in the underlying basement rocks. Cumberland field (Fig. 24) is located along the axis of a magnetic high (with a 100-gamma closure). Subsurface geological information has led Cram to the conclusion that there is an anticline here in the pre-Cambrian 13,000 ft. deep and that the basement surface is faulted upward almost to the surface on the northeast side of the field.

Jackson gas field in Mississippi is located over a magnetic high 20 miles in diameter with more than 1,200 gammas closure. Although the drill has penetrated more than a mile, the source of the anomaly has not been reached. The shape of the magnetic profile indicates the existence of a large igneous plug, and this is believed responsible for the domal uplift which has trapped the gas in the overlying formations. The largest

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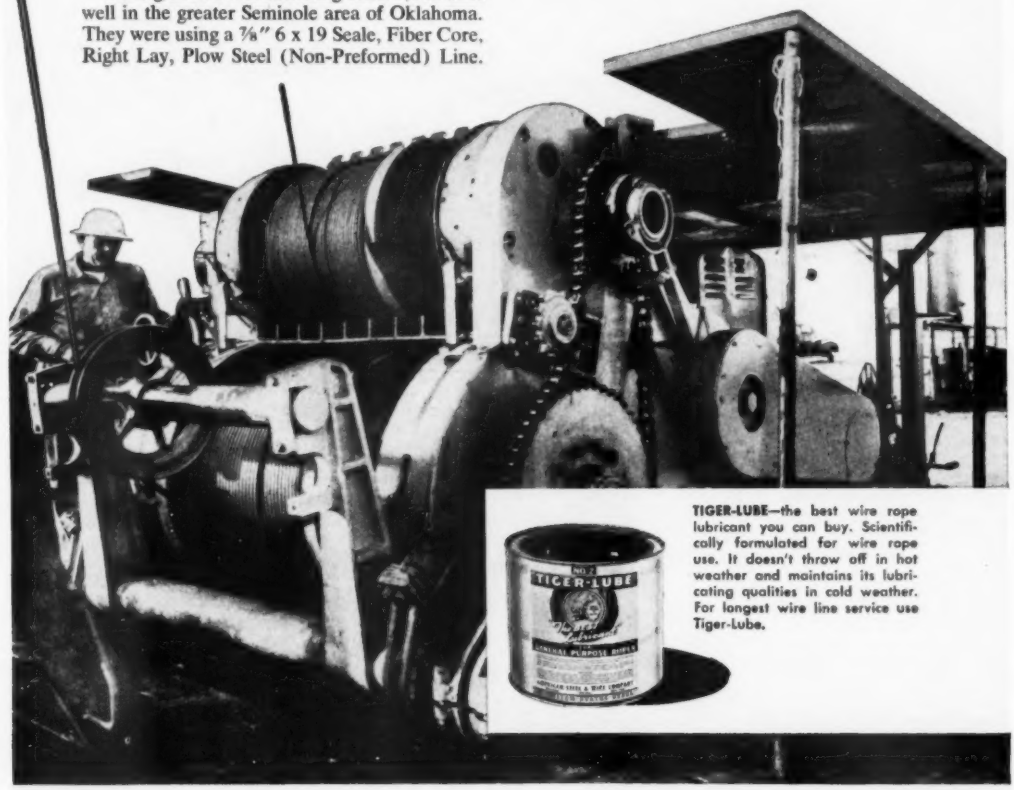

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field for which discovery can be credited to a magnetic survey is Hobbs field of Lea County, New Mexico. The discovery well here was drilled in 1927 on the basis of a magnetic survey followed by torsion-balance work.

Weak negative magnetic anomalies are to be expected over salt domes because of the contrast between the slight negative susceptibility (about -0.5×10^{-6} c.g.s.) of the salt or cap rock and the small positive susceptibility (10 to 50×10^{-6} c.g.s.) of the surrounding sediments. Thus far, no oil pools associated with salt domes have been discovered by the magnetometer, although several experimental surveys over known domes have revealed anomalies of the expected magnitude. Fig. 25 shows the 20-gamma negative anomaly observed in a Magnolia Petroleum Co. experimental magnetometer survey over the Hockley salt dome, the cap rock of which comes within 100 ft. of the surface.

Garber field in Oklahoma, as well as Healdton and Oklahoma City fields, show negative magnetic anomalies, the one at Garber reaching a maximum of 300 gammas. Such lows have been variously attributed to well casing, thickening of magnetic sediments, erosion of highly magnetic sedimentary material from the crest of the structure, and irregular basement magnetization.

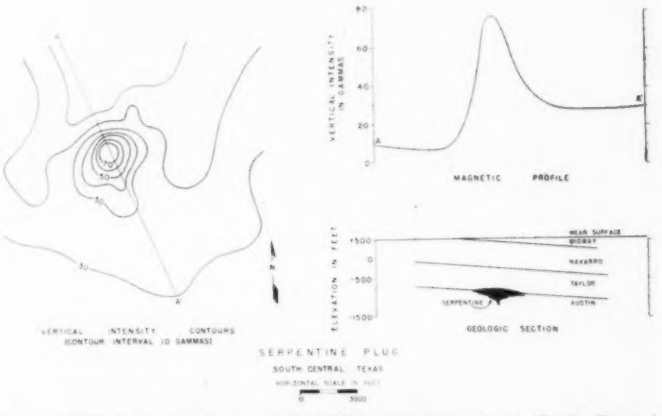


Fig. 23—Magnetic anomaly over oil-bearing serpentine plug in South Central Texas. (After J. W. Peters, Mines Mag. Colo., 1949.)

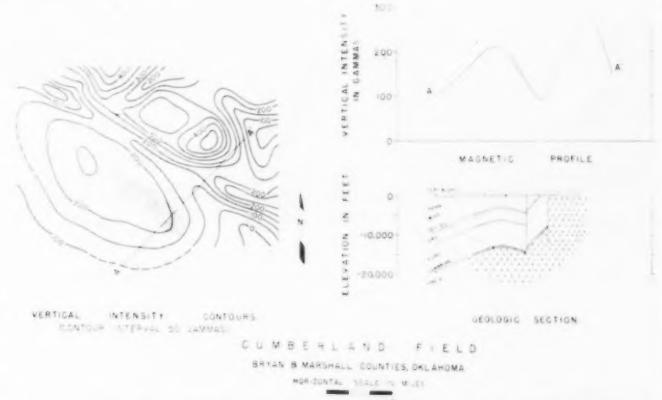


Fig. 24—Magnetic intensities observed over Cumberland field, Oklahoma. Geologic section also shown. (After J. W. Peters, Mines Mag. Colo., 1949.)

Airborne Magnetometer

THE discussion of magnetic prospecting methods has dealt for the most part with the long-established procedures used for measurements on the earth's surface.

During and after World War II, newer techniques were perfected for magnetic mapping from the air. These have turned out to be highly effective, and widespread areas in all the continents of the world have been surveyed by airborne magnetic instruments.

The advantages of geomagnetic measurements from the air were recognized long before the instrumentation was developed that made them possible. The most obvious one is the tremendously greater speed at which operations can be carried on.

Another is the possibility of eliminating disturbing magnetic effects from near-surface irregularities which make it difficult to recognize low-gradient anomalies from deep-seated geologic features. Still another lies in its ability to obtain data over swamps, jungles, mountains, and other terrain inaccessible to a ground surveying party.

Operating Procedures

Location of magnetometer head with respect to the plane.—Three arrangements have been used for the

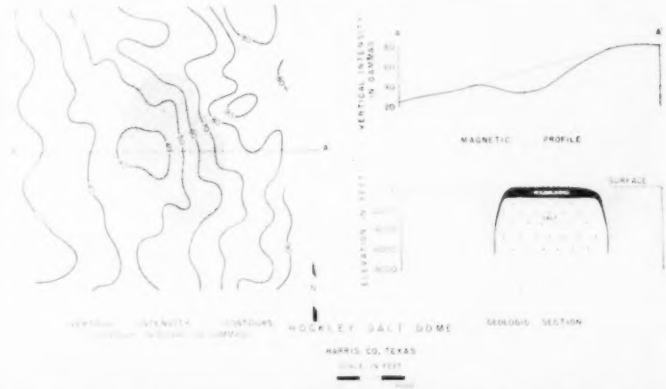


Fig. 25—Negative magnetic anomaly over Hockley salt dome, Texas. (After J. W. Peters, Mines Mag. Colo., 1949.)

Fig. 26—Airborne magnetometer being trailed in flight. (Frost Geophysical Corp.)

location of the magnetometer head during flight. The principal objective in each case is to remove magnetic effects from iron in the plane itself.

The most usual method is to tow the head (often referred to as the "bird") at the end of a cable, 80 to 100 ft. long, attached to the bottom of the plane (Fig. 26). At this distance, the magnetism of the plane is negligible. The outer case is streamlined for maximum stability and minimum air resistance and is equipped with fins to prevent rotation. The "bird" is lowered through a trap door in the floor of the cabin after the takeoff.

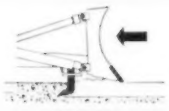
Photographic position location.—When a continuous-strip camera is used for location, a complete record is obtained of the plane's flight path. This can subsequently be compared with a standard aerial photo assemblage for transcription to a map. When the plane passes over identifying features on the ground, the observer presses a key which simultaneously puts a fiducial mark on the moving magnetometer tape and photographs on the strip the face of an electric number counter which changes each time the key is pressed.

When intermittent rather than continuous photography is employed, a similar correlating system is used. The key also prints an edge mark on the tape from the continuously recording radio altimeter. Thus the position, height above ground, and magnetic reading are coordinated at frequent intervals during the course of the flight. In some systems the instrument panel is also photographed when the key is pressed so that all sensitivity settings and balance positions are repeatedly recorded. The operator can then change sensitivity or rebalance at will without having to keep a written record.

Shoran location.—When Shoran is employed for surveying, the ground stations must be located within line-of-sight range of the plane. For water operations, a series of boats stand anchored at accurately surveyed positions about 30 miles apart, and distances are continuously recorded to the two nearest ones, the position at any time being determined later by striking arcs of the proper length from each transmitting boat position and noting where they intersect.

One procedure is to fly in successive circles or crescents about one of the Shoran transmitters, noting the distance from the second transmitter at 1-mile intervals around the trajectory. Fig. 27 illustrates how this technique would be used operationally when three boats with Shoran transmitters are employed. A moving tape records the departure of the actual radius from a predetermined value; pilot notes this to correct his course.

Since the departure curve can be calibrated in terms of distance it is possible to correct the trajectory as mapped by reference to the deviation data. Another method is to fly in straight lines, keeping on course by



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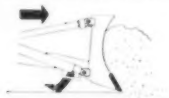

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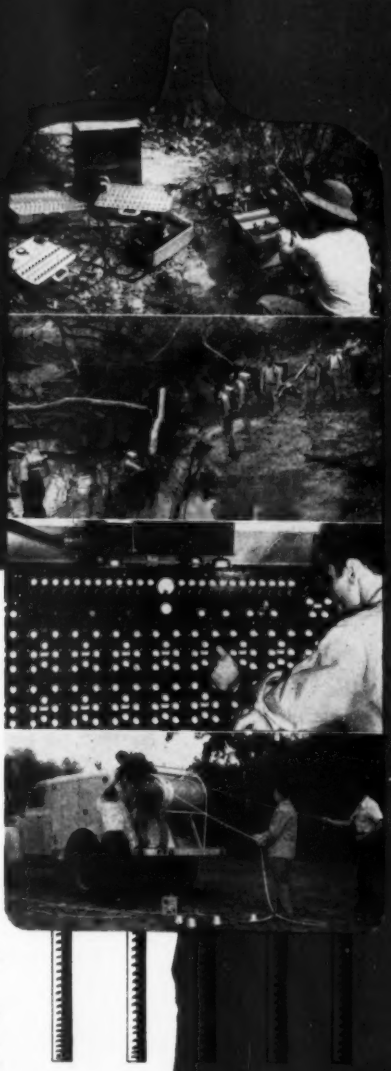

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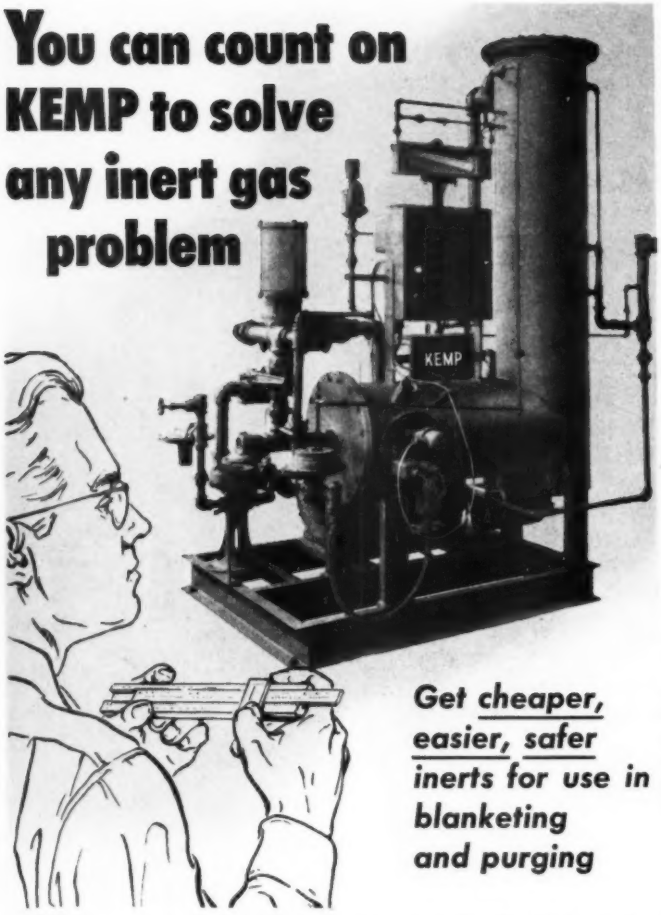

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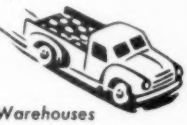

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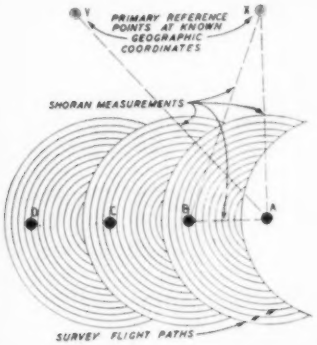

Fig. 27—Flight pattern for position location by Shoran. Distance from boat 1 at A to boat 2 at B measured by Shoran. Location of A and B also measured by Shoran to primary reference points. Plane then drifts around A at specified radii. Plane's position on track around A is determined by its distance from B. While plane works around A and B, boat 3 is proceeding to C, where it is triangulated in by Shoran. After completion of crescent AB, the plane drifts at specified radii around B, position being spotted by distance from C. Meanwhile boat 1 is proceeding from A to point D. (After Burns, The Oil and Gas Journal, 1947.)

use of a Shoran controlled "pilot direction indicator" (P.D.I.).

For flying over land, Shoran transmitters are usually put into trucks which stand at known positions during operation and which move to new positions during the course of the day's flight as new areas are covered. Three trucks are used, two transmitting and one moving into a new position at any given time.

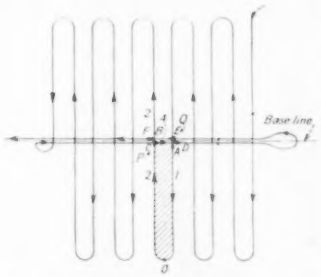

Fig. 28—Standard flight pattern used with photographic position location to facilitate elimination of diurnal variation. Procedure for correcting for this variation exemplified as follows:

Magnetic readings at A (leg 1), B (leg 2), C, D (leg 3), and E, F (leg 4) are R_A, R_B, etc.
Average of R_C and R_F is R_P.
Average of R_D and R_E is R_Q.
Assume R_P and R_Q are correct for respective crossing points.
Correction at $Q = R_A - R_Q = C_Q$.
Correction at $P = R_B - R_P = C_P$.
Correction at $O = (C_Q + C_P)/2$.

Elimination of diurnal variation.—The flight pattern is generally so laid out that diurnal variation can be expeditiously removed. If the plane flies in a large loop crossing an earlier portion of its path, any difference between the two magnetic readings at the point of crossing is attributed to diurnal variation and is distributed over the entire loop.

If circular flight paths of the type illustrated in Fig. 27 are employed, it is only necessary to measure differences at convenient intersections of circles around adjacent central points. The more usual pattern is that illustrated in Fig. 28. This consists of a large number of parallel legs all perpendicularly bisected by a base line along which the plane flies in opposite directions within a time interval that is so short that there will be no measurable diurnal variation while it is flown.

Differences between magnetic intensities at points of intersection with the base line are distributed among the various individual loops as shown in the diagram. A ground magnetometer is kept at the base of operations to detect the onset of any magnetic storms; in such an event the party is instructed to conclude operations for the day.

Height of flight path.—The height of the flight above the ground may vary anywhere from 300 ft. to the limiting altitude to which the plane can climb. The pilot is instructed to fly at a constant altitude above sea level, but necessary deviations from this altitude are recorded on the altimeter tapes.

The height chosen for a given survey depends on the purpose of the

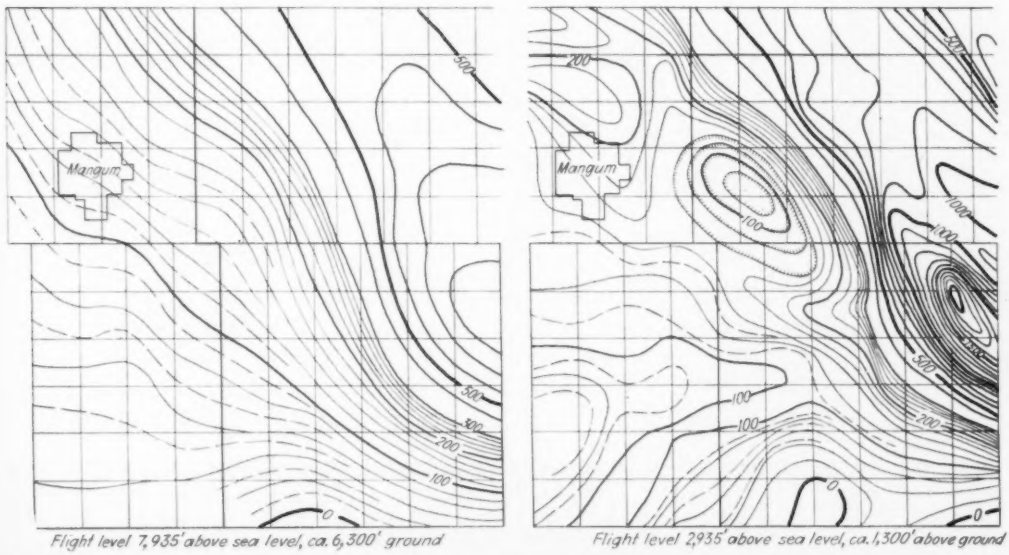

Fig. 29—Aeromagnetic maps made at two elevations showing total intensities in Mangum, Okla., area. (U. S. Geological Survey.)

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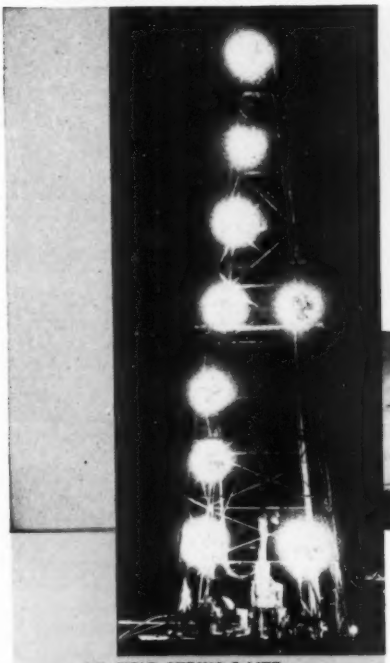

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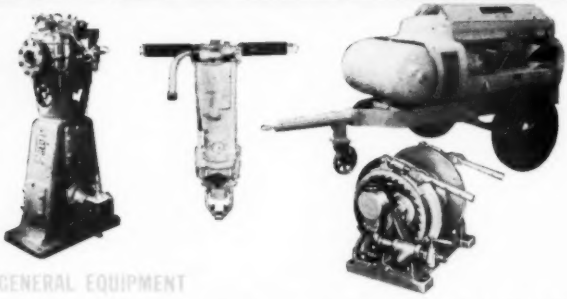

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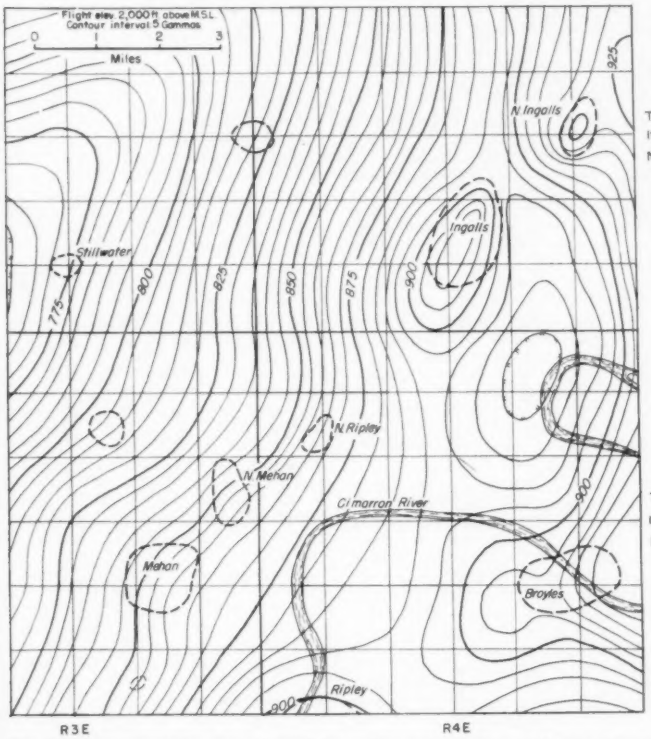


Fig. 30—Aeromagnetic map of total intensity over portion of Payne County, Oklahoma. (Frost Geophysical Corp.)

mapping, the nature of the terrain, and the disturbance to be expected from superficial sources of magnetic field at and just below the surface of the ground. A survey of basement structures that might be associated with overlying oil traps would probably be flown at a higher altitude than a survey for near-surface magnetic ore veins.

Advantages and Limitations

Advantages.—The advantages of aeromagnetic prospecting over magnetic prospecting on the ground may be listed as follows:

1. The most obvious advantage of the aerial magnetometer is its speed. A crew of four men made an aerial survey in 2 months over the Adirondacks, covering an area which would have required 27 four-man ground crews in order to procure the same data in a 6-month field season.

2. Because of this advantage in speed, the cost of an aerial survey is much lower than an equivalent ground survey if the area to be covered is sufficiently extensive to justify the high fixed costs. A ground survey with a station spacing of a few hundred feet (as is usual in mineral prospecting) costs $30 to $60 per linear mile; a standard airborne survey costs as little as $5 per mile; and a helicopter survey runs about the same on an extended survey.* The present rate of coverage by airplane is about 500 miles per day.

3. The airborne magnetometer can be used over water and terrain that is inaccessible for ground operations. This is most advantageous in remote parts of the earth where transportation facilities are highly undeveloped.

4. In general, the effects of instrument drift and diurnal variation are minimized in aerial surveys on account of the speed of the operation.

5. Because of the height of the plane, magnetic materials on the earth's surface, such as in pipes, rails, buildings, etc., do not affect the record, whereas such extraneous sources of magnetism continually interfere with the usability of ground magnetic data.

6. In the same way, the effects of extraneous magnetic rocks, sands, and dikes at or just below the surface will not interfere with the recognition of anomalies caused by deep subsurface bodies. The flight elevation can be varied for maximum discrimination.

7. Smoothness of the data admits freer use of analytical methods.

Disadvantages.—The following disadvantages and limitations of the aerial methods should also be noted:

1. Flight lines cannot be spaced closer than ¼ mile. In a survey for small ore bodies this would be an obvious limitation.

2. The accuracy of the results in aerial work is always limited to the accuracy of the map on which the magnetic data are transcribed. In some areas available maps are too incomplete or inaccurate for reliable location of magnetic features. There will be an error of 50 ft. in location even on the most precise maps when the flight altitude is 1,000 ft.

3. The minimum cost of an aeromagnetic survey is high because a heavy plane, preferably two-engined, and at least three men are required to begin operations.

If the area to be covered is large, the data that can be accumulated in a short time justify the minimum investment. If the area is small, this type of survey becomes prohibitive on the basis of cost per mile. No small operator can afford to use it, although he might be able to meet the cost of a ground magnetometer survey.

*These figures are for 1949.

Gravity Prospecting

THE rapidity of technological improvement that has characterized exploration geophysics is in no way better exemplified than by the changes during the past three decades in the instrumentation used for gravity prospecting. The earliest commercial instrument, the torsion balance, was replaced after 10 years of extensive service by the more versatile and faster operating gravimeter, an instrument which since its introduction has been improved steadily with respect to both precision and ease of handling.

The term **gravimeter,** or **gravity meter,** is commonly used to denote any instrument in which the acceleration of gravity is determined by measuring the force necessary to support a suspended mass, this force usually being applied by a spring and measured by the extension of the spring. A gravimeter must be calibrated, usually by noting its readings at a number of stations where the acceleration of gravity has been measured by the use of pendulum apparatus. Some gravimeters, however, are calibrated by tilt.

Anomalies sought in prospecting are caused by subsurface structures such as salt domes or buried ridges and have peak values seldom more than 1 or 2 milligals. They are superimposed on a normal gravitational acceleration of nearly a million milligals.

Since we are interested in gravity differences rather than in the absolute values of gravity, there is no necessity for an instrument that measures gravity directly. Actually the finest gravity pendulums give results that are barely reliable to the nearest milligal, so that pendulum measurements could not yield the 0.1-milligal differences that are required in modern gravity prospecting without further refinement in design. It is much simpler to devise an instrument that will measure such small differences by interpolation between calibration values determined by pendulum measurement.

Although instruments for the direct measurement of gravity differences are now employed almost universally in the United States, the torsion balance, which measures gradients and curvatures rather than gravitational accelerations, was operated very extensively as a prospecting tool until the early 1930's. In addition, pendulum apparatus was operated intensively by one company for a period of several years. Although both instruments are now essentially obsolete as far as prospecting is concerned, data obtained by them are still reviewed frequently in assessing areas where interest has been renewed long after the original surveys.

The Gravimeter

The gravimeter, or gravity meter, measures small variations in the vertical component of gravity directly. Since such an instrument must detect differences of 0.1 milligal or less to be useful in prospecting great ingenuity in design is required to achieve this sensitivity. Although there is a wide variation in the design of different kinds of gravimeters, there are fundamentally only two types, the stable and the unstable.

The stable gravimeter contains a responsive element (such as a spring) with a displacement from equilibrium position proportional or approximately proportional to the change in gravity from its equilibrium value. Since such displacements are always extremely small, they must be greatly magnified by optical mechanical, or electrical means. Unstable gravimeters are so designed that any change in gravity from its equilibrium value brings other forces into play which increase the displacement caused by the gravity change alone.

In the discussion to follow, only gravimeter operations and reductions will be considered, since the torsion balance and pendulum are no longer used to any appreciable extent in gravity prospecting.

Measurement of Gravity on Land

Determining station locations.—In planning a gravity survey, one of the most important considerations is the location and spacing of stations. In a reconnaissance survey for large oil-bearing structures the distance between stations would of course be much greater than in a survey to locate small, near-surface ore bodies. The standard procedure in gravity prospecting over sectionized country is to establish stations at the corners of a ½-mile grid, so that the closest separation of adjacent station is ½ mile. There are wide departures from this spacing. In Kuwait, for example, a Gulf crew established a spacing of 2 km. after preliminary tests with a closer spacing indicated a very regular gravity picture.

The recent development of easily portable gravimeters has freed operators from the necessity of placing stations only along roads or other lines accessible to trucks. It is still easiest and most economical, however, to use vehicle where possible.

Often it is desirable to shift locations from their position on a uniform grid to avoid proximity to topographic features that would require much larger and more precise corrections when near the station than when a matter of only a few hundred feet away. A gravity reading, for example, on the summit of a small knoll would be affected much more by the mass of the knoll itself than would readings a short distance to the side. In both cases terrain corrections would have to be made, but the uncertainty in the exact shape and density of the knoll would not contribute nearly as much error in the latter instance.

Surveying.—Surveying expense is the major item in the budgets of most gravity parties. Both elevation and geographical position must be known accurately. Spirit leveling is usually necessary, but in some cases barometric leveling is adequate.

The methods of surveying and the cost of this part of the work vary greatly depending on the ease of transportation and on the scale and quality of existing maps and level nets. The degree of necessary precision is established by the sensitivity of observed gravity to elevation and latitude. An error in elevation of 1 ft. should give rise to a difference of 0.07 milligal in the elevation correction and an error of 100 ft. in the north-south coordinate of position should give an error of 0.03 milligal at middle latitudes.

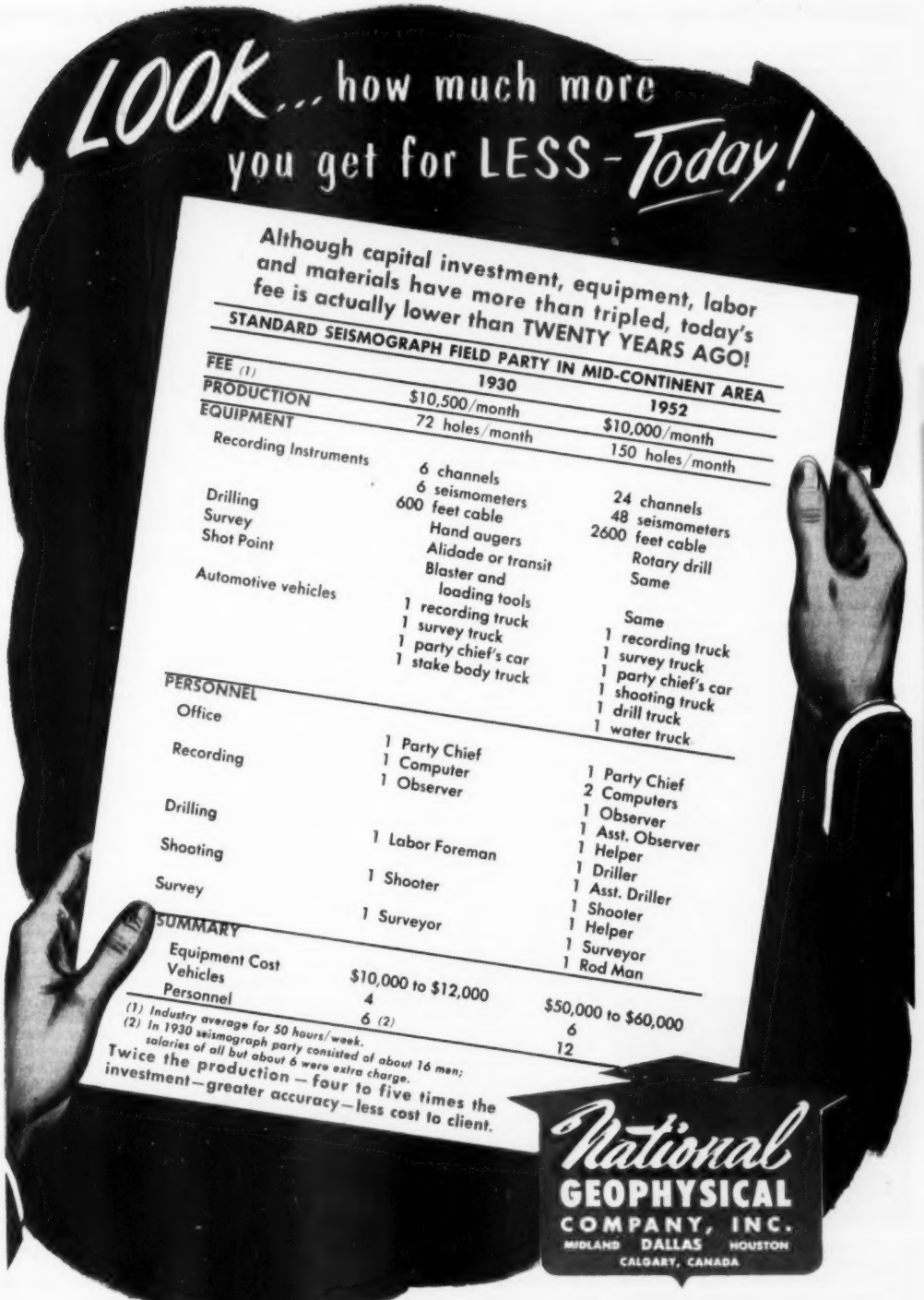
A precision of 0.1 ft. in elevation is consequently sought in the final station elevations, and this can be achieved only by close spacing of transit positions and short chain lengths on slopes. The cost of such surveying is considerably higher than that of topographic surveys made in connection with other geophysical methods.

When speed and economy are more dominant considerations than the utmost attainable precision, it is sometimes desirable to determine elevations barometrically rather than geodetically. The standard barometric equipment used by geologists to determine approximate elevations for mapping purposes is generally not precise enough for commercial gravity work. A special instrument has been designed which measures differences in barometric pressure with much higher precision, responding to changes in atmospheric pressure equivalent to elevation differences as small as 0.1 ft. The limit of accuracy with which elevation difference can be determined barometrically is imposed by meteorological conditions. As the atmosphere is usually less disturbed in lower latitudes, barometric leveling can give greater accuracy there.

Surveying for offshore gravity projects, particularly when the stations are out of sight of land, requires elaborate radio or radar systems to give station locations.

Transportation and operation of the instrument.—Most gravimeters now used are set up inside a truck or passenger automobile on a tripod which is lowered to the ground through holes in the floor. The heaters for thermostatic control required by most instruments are continuously connected by cable to the truck's

Fig. 31—Portable Gulf gravimeter in operation. Weight of instrument (exclusive of battery box) is 22 lb. (Gulf Research & Development Co.)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$10,500/month
1952
$10,000/month
PRODUCTION
72 holes/month
150 holes/month
EQUIPMENT
Recording Instruments
6 channels
6 seismometers
600 feet cable
24 channels
48 seismometers
2600 feet cable
Drilling
Hand augers
Rotary drill
Survey
Alidade or transit
Same
Shot Point
Blaster and loading tools
Same
Automotive vehicles
1 recording truck
1 survey truck
1 party chief's car
1 stake body truck
Same
1 recording truck
1 survey truck
1 party chief's car
1 shooting truck
1 drill truck
1 water truck
PERSONNEL
Office
1 Party Chief
1 Computer
1 Observer
1 Party Chief
2 Computers
1 Observer
Recording
1 Asst. Observer
Drilling
1 Labor Foreman
1 Helper
1 Driller
Shooting
1 Shooter
1 Asst. Driller
1 Shooter
Survey
1 Surveyor
1 Helper
1 Surveyor
1 Rod Man
SUMMARY
Equipment Cost
$10,000 to $12,000
$50,000 to $60,000
Vehicles
4
6
Personnel
6 (2)
12
(1) Industry average for 50 hours/week.
(2) In 1930 seismograph party consisted of about 16 men; salaries of all but about 6 were extra charge.
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battery. There are many localities, however, where other means of transportation are required on account of special terrain conditions. In the geophysical investigation of Naval Petroleum Reserve No. 4 in northernmost Alaska, gravimeters are flown from station to station in light airplanes on skis or pontoons.

In the foothills of Alberta, a Gulf party transported its gravimeter and battery by pack horses. For marsh country in southern Louisiana, where wheeled vehicles cannot travel at all, the problem of transporting gravimeters and other geophysical equipment has been solved for well over a decade by "marsh buggies." In some areas, finally, there seems to be no effective substitute for carrying gravimeters on foot. The lightweight Gulf gravimeter illustrated in Fig. 31 was designed for use away from roads. With the Worden gravimeter, of course, carrying the instrument involves no hardship.

Surveyors will normally keep several days ahead of the instrument operators, who will find their station locations marked by flags which the surveying crew has left. At each station, the instrument must be carefully leveled before it can be read. It is standard procedure to take three readings in rapid succession at each station. When all stations are alongside roads, it is often possible to cover as many as a dozen of them in an hour.

Regional gravity surveys.—Regional gravity surveys, in which station spacings are measured in tens or even hundreds of miles, have been conducted in many parts of the earth over the past 75 years for studying the figure of the earth as well as large-scale geologic features. From such studies valuable information can be derived on the distribution of mass within the earth crust, isostatic adjustment, and tectonic history. In early surveys of this type measure-pendulum equipment and then only penedulum equipment and then only within a precision of several milligals. The gravimeter has in recent years become available for such regional gravity surveys, giving readings that are much more precise in a fraction of the time.

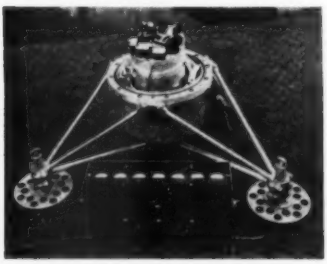

Fig. 32—Gulf underwater gravimeter and control box with top of watertight case removed. (Gulf Research & Development Co., picture published in Geophysics, 1941.)

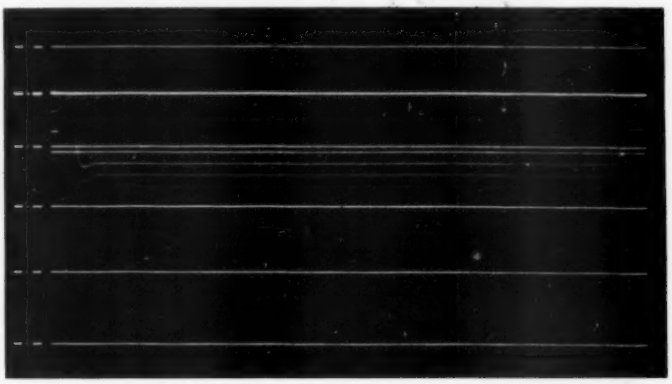

Fig. 33—Sample Gulf underwater gravimeter record. Heavy lines marked by dot-dash identification are fiducials for scaling. Heavy line just below third fiducial is zero. Light lines are multiple images of light beam reflected from gravimeter mirror. (Gulf Research & Development Co.)

The principal difference between prospecting surveys and regional surveys lies in the station spacing. In the latter the separation of stations would be of the order of 10 miles, the only practical limitation being the necessity for returning to previously occupied stations for elimination of drift. Elevations, for reasons of economy, are obtained from established bench marks (at which stations are located when possible) or barometrically, rather than by special topographic surveys.

Measurement of Gravity in Water-Covered Areas

The measurement of gravity in water-covered areas is beset by many difficulties. If one attempt to take a reading with standard land instruments on board a boat, he finds that the roll of the vessel, even in the calmest weather, introduces accelerations that cannot be separated from the acceleration of gravity. Ever since the awakening of interest in potential petroleum reserves beneath offshore waters, as well as below the many lakes and shallow embayments of the oil provinces, various special devices have been developed to make possible gravity measurements in such areas.

Tripod measurements.—The earliest method was to set up large portable platforms with tripods resting on the water bottom, the top surfaces being out of the water. The gravimeter could then be mounted on the platform and read. The principal difficulty here lay in the instability of the platform due to motion from waves, wind, and tidal currents in all but calmest water. For small shallow lakes and protected estuaries this arrangement was nevertheless quite satisfactory.

Remote-control methods.— Shortly before this country's entrance into World War II, Gulf Research & Development Co. perfected apparatus for operating a standard Gulf gravimeter on the water bottom entirely by remote control. Fig. 32 is a photograph of the equipment with the case partly opened. Cables transmit impulses for the various control mechanisms which are operated from a small ship above. The instrument is leveled on the bottom by motor-driven gimbals so designed that the level in two perpendicular directions can be controlled independently and simultaneously.

A photocell unit inside the case indicates the departure from horizontal in each direction on a micrometer in the control box. The operator can regulate the level within 10 in. of arc by bringing the meter to zero through remote-control manipulation of the leveling motor.

Readings are recorded by a camera contained within the gravimeter assemblage itself. The film, which moves slowly through the camera during an observation, is loaded and unloaded through a handhole when the instrument is brought to the surface. Fig. 33 shows a sample record in the course of a reading. The five heavy lines labeled by the dot-dash code symbol are fiducials for scaling. The heavy line just below the third fiducial represents zero. The lighter lines are multiple images, with equal separation, of the light beam reflected from the moving gravimeter mirror. Records are read by a special micrometer slide comparator.

Because of delays in transportation and in handling the heavy equipment, which weighs, with its attached

Fig. 34—Diving bell for underwater gravimeter operations, developed by Robert H. Ray Co. (Robert H. Ray Co.)

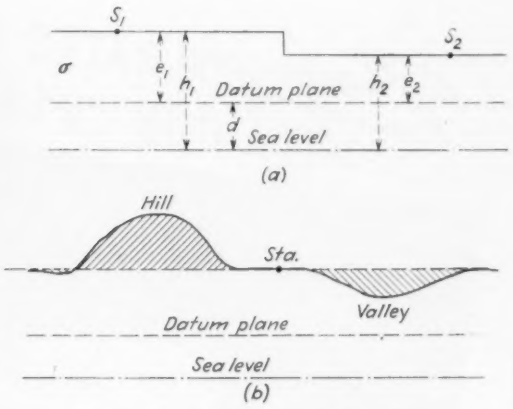

Fig. 35—Elevation and terrain corrections.

(a) Bouguer correction (to datum plane) at S_1 is $2\pi\gamma\sigma e_1$ or $0.025e_1$ if σ is 2 and e_1 in ft. At S_2 it is $2\pi\gamma\sigma e_2$. Free-air correction is $0.094e_1$. (b) Terrain correction removes effect of hill by adding its upward attraction at station and compensates for valley by adding attraction it would exert at station if filled in. Result is to flatten all topography to level of station so that Bouguer correction will reduce station to datum.

lead, about 650 lb. in air, Gulf underwater parties make only six stations in the course of an average working day.

Since the war several other remote-control instruments for underwater gravity measurement have been introduced.

Diving bells.—A spectacular development in underwater gravimeter operations has been in the use of a large diving bell which is lowered to the bottom with a gravimeter and its operator inside. Fig. 34 illustrates the arrangement. After the hatch is closed the bell is lowered with a boom from the stern of a barge, the observer maintaining telephone communication with the barge's personnel.

There are numerous safety features, including an emergency air supply and an escape hatch in the lid. Although such devices have been used extensively in water as deep as 125 ft., they have been essentially superseded by the remote-control type of apparatus.

Reductions of Gravity Data

In order to be most useful in prospecting, the observed gravity data must be corrected for station elevation, the influence of nearby topography, and latitude. In general all gravity values are reduced to a datum plane, but this plane may or may not be at sea level. Absolute values of gravity are almost never used on commercial gravity maps; thus it is only necessary that the values mapped be consistent with one another for the datum finally chosen.

When the corrected gravity values are plotted on a map and contoured, the resulting picture as it stands will seldom give much usable information on the subsurface geology until it is analyzed by suitable interpretation techniques. If the geologist attempts to read gravity contours as if they were equivalent to structure contours such as those he obtains from drilling logs, his conclusions will be highly erroneous. In an area where there is no independent information on sub-

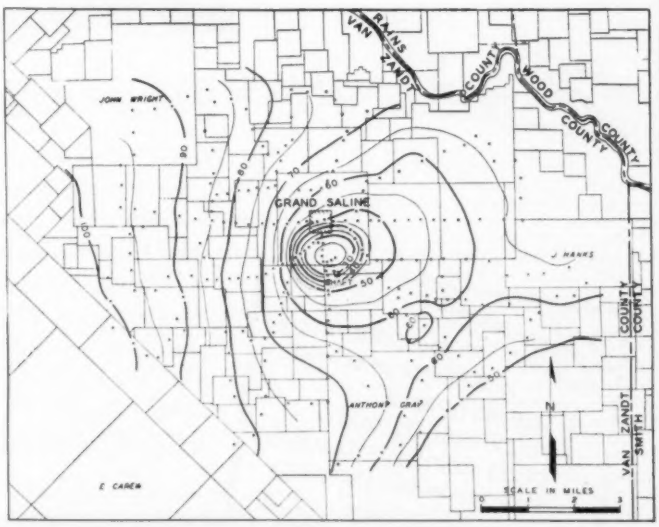

Fig. 36—Gravity contours over Grand Saline salt dome. Free-air, Bouguer, and latitude corrections have been made, but there is no adjustment for regional trend. Each gravity unit is 0.1 milligal, so that contour interval is 1 milligal. Stippled area represents position of salt mass. (After Peters and Dugan, "Geophysical Case Histories," S.E.G., 1949.)

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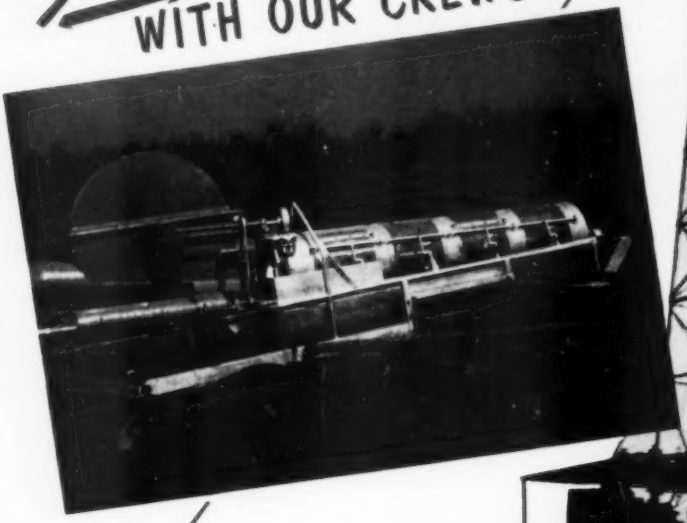

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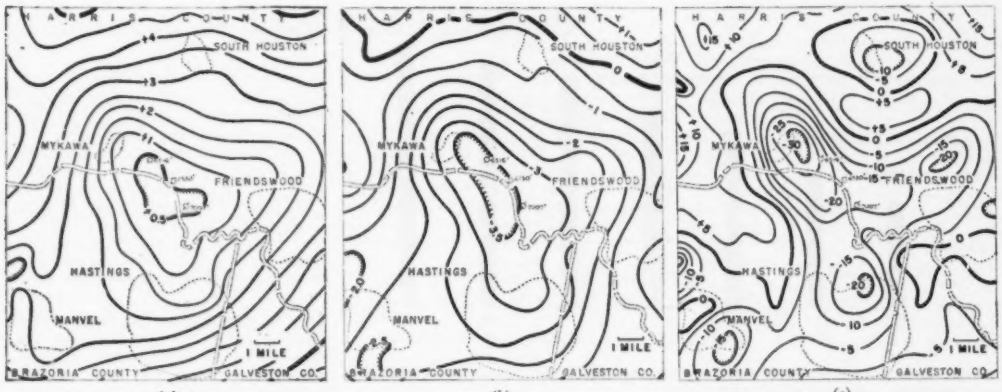

Fig. 37—Gravity maps of the Mykawa-Friendswood-Hastings-Manvel salt-dome area near Houston. (a) Observed gravity, contour interval 0.5 milligal. (b) Residual gravity, contour interval 0.5 milligal. (c) Second vertical derivative of gravity, contour interval 5×10^{-9} c.g.s. unit. (After Elkins, Geophysics, 1951).

surface geology, it is impossible to translate gravity data into reliable estimates on the structure.

The more the available data from other sources, the more restricted will be the questions that the gravity information is called upon to answer and the more definite the answers that can be expected. It is important for all who use gravity data—and this means geologists and executives, as well as geophysicists—to realize that interpretation is not a clear-cut process which can be relied on for a unique answer but is instead subject to numerous limitations which decrease as the independent control increases.

Isolation of Residual Gravity Effects

Many areas where gravity surveys are made have deep-seated structural features causing variation in gravity at the surface which are much larger in areal extent than the usual structures of interest in prospecting. For example, the Amarillo-Wichita uplift, a 200-mile-long basement feature crossing western Oklahoma and the Texas Panhandle, gives rise to a regional gradient along its southwestern flank of about 10 milligals per mile, the gravity value after Bouguer correction increasing at that rate as one moves away from the axis of the uplift.

In the Rio Grande Valley, there is an increase in regional gravity of about 1 milligal per mile as the Gulf of Mexico is approached from a point 70 miles inland. Such gradients often distort or obscure the effect of structures, such as salt domes and buried ridges, that might result in oil traps. For this reason it is customary to subtract out the regional change in order to isolate more clearly the structural features in which we are primarily interested. There are several methods of removing regional gravity so as to leave these "residuals," as they are called. Some are graphical, others analytical.

Regardless of the method used to evaluate and eliminate regional gravity changes, it is important to recognize that the basic criteria for separating regional anomalies from those of significance in prospecting are the area covered by the anomaly and in many cases the magnitude of the anomalous gravity readings.

Second Derivative Gravity Maps

Where the spacing of the gravity readings is close and where their precision is high, the second derivative method constitutes a most powerful device for resolving and sharpening anomalies of small areal extent. On maps of observed gravity such anomalies are likely to be obscured or hidden altogether by regional trends as well as by the effects of other small features in close proximity. As the vertical rate of change of the change of gravity with depth, the second vertical derivative magnifies the gravity effect of smaller and shallower structures with respect to that of the larger scale features, which are usually at greater depths. Thus the geologic structures of greatest interest in oil and mineral exploration are emphasized at the expense of large structures within the basement. (See Fig. 37.)

Choice of Density as an Interpretation Problem

In the interpretation of gravity anomalies, it is necessary to estimate the densities of the subsurface rocks involved before one can postulate their structure. For this reason it may be worth while to give some data on the densities of representative rocks in regions where gravity surveys are ordinarily made. It is not the absolute densities but the density contrasts that are significant in gravity calculations. Among sedimentary rocks these contrasts are almost always small, seldom exceeding 0.25 g./cm.^{3} Moreover, there is a range of variation in the possible densities of almost any type of rock, and the uncertainty as to the proper value to use in a given instance is one more factor that can contribute to the probable error of gravity interpretation.

Each type of sedimentary rock covers a wide range of densities and this range is little different for sandstones, shales, and limestones. For this reason, it is highly desirable that all possible geological information on the subsurface stratigraphy be utilized in choosing density values for gravity calculations. Igneous rocks in general tend to have higher density than sedimentary formations. Even here, however, there is substantial overlap between the densities of sedimentary and igneous types as well as between those of the various kinds of igneous rocks themselves.

Despite the considerable range of variation in the densities of different types of rock, it is often necessary to use average values in gravity calculations for areas where the kind of rock is known but no densities have been determined. Fig. 38 indicates average densities obtained from a large number of laboratory measurements on core and surface samples made by Magnolia Petroleum Co.

In many areas there is a regular increase with depth in the density of the sedimentary section on account of compaction.

Determining Subsurface Structure from Gravity Data

Whereas a given buried mass will give a single predictable gravity effect at any chosen point on the sur-

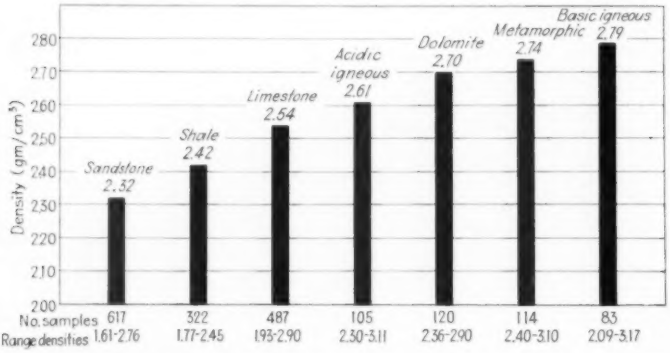

Fig. 38—Average densities of surface samples and cores based on laboratory measurements. (Magnolia Petroleum Co.)

face, any gravity profile could, on the basis of physical reasoning alone, be equally well produced by an infinite number of possible mass distributions.

To consider a simple example, any buried sphere will give rise to the same gravity profile as would a point source of the same mass located at its center. If the mass and center of the sphere are fixed, the density and radius could have any combination of values that would give the right mass, and there would be no way of separating one from the other by analysis of the gravity profile alone.

If we knew the density we could then determine the radius, but even then we could not be certain that the body is a sphere just because the gravity profile has the same form as that for a sphere. Entirely different spatial distributions of subsurface mass could yield precisely the same surface gravity.

The limitations of the gravity method in defining subsurface structure are demonstrable by standard potential theory. Widely different mass distributions below the ground can give the same gravity picture on the surface.

Fig. 39 shows a number of subsurface structures which, in the absence of other geologic information, could equally well account for an observed gravity anomaly. If it is assumed that the anomaly results from undulations in the surface of a basement which has a fixed density contrast with the sediments above, the structure could have any of the shapes shown in the middle part of the figure. The lower part of the diagram shows an entirely different geological situation, a schist penetrated by an intrusive and overlain by sedimentary rock, which could give rise to the same anomaly.

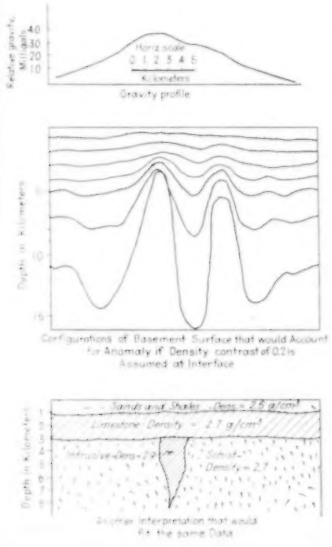

Fig. 39—Alternative interpretations of a hypothetical gravity anomaly. (After Skeels, Geophysics, 1947.)

Need for independent geologic information.—Fortunately, it is seldom that the interpreter has no basis other than gravity data upon which to solve for the subsurface structure. Any independent control such as is obtained from drilling logs or seismic data greatly reduces the ambiguity that would otherwise be inevitable in the interpretation. The range of uncertainty is now narrowed and the number of variables can be reduced to the point where the final solution has useful significance.

If, in the example shown in Fig. 39, a single well were drilled somewhere along the profile, penetrating the basement surface, data would be available on the densities of the sedimentary section and basement rocks as well as on the depth of the interface at one point. Assuming that these densities remain laterally uniform beneath the entire area, it is then possible to calculate the shape of the basement surface from the gravity data with greatly increased reliability. Even then there is no assurance that the densities do not change as one moves away from the well, so that the final picture will still be subject to uncertainty on this score.

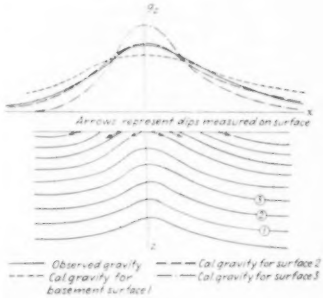
Arrows represent dips measured on surface
Observed gravity
Cal gravity for basement surface!
Cal gravity for surface 2
Cal gravity for surface 3

Fig. 40—Estimating depth of buried igneous ridge by extrapolating surface structure downward and comparing calculated gravity at various assumed depths with observed profile. Surface 2 appears to give best fit.

It is often possible to make use of information obtained by surface geology to limit the possibilities and guide the assumptions upon which the gravity interpretation is based. Suppose, for example, that surface observations reveal an anticline coincident with a gravity high, as in Fig. 40. The high is attributed on the basis of regional geology to a buried basement ridge at the anticline's core. The shape of the ridge can be estimated from the surface dips.

The only unknown is the depth of the basement, and this can be estimated from the gravity data by placing the ridge successively at a number of depths and computing each of the resulting gravity profiles graphically or analytically.

It is seen that one of these profiles gives a closer fit to the observed gravity profile than do any of the others but does not coincide with it exactly. The departures of the calculated curve from the observed one would then indicate how the assumed structure should be changed in order to secure a better fit.

Although the geological control makes the final picture considerably more reliable than it would otherwise be, the structure so deduced is not unique. Density inhomogeneities or structural features not reflected in the surface geology could make the interpretation entirely wrong.

Integration of Geophysical Methods

IN many exploration problems, a combination of geophysical methods turns out to be more effective and even more economical than any single method used alone. This is particularly the case with petroleum prospecting, where relatively inexpensive reconnaissance surveys, such as those with gravimeters or magnetometers, make it possible to confine activity with more detailed but more expensive methods, such as seismic reflection, to the most promising areas. In geophysical exploration for minerals, it is often profitable to employ a number of geophysical methods so as to take advantage of the widest possible range of physical properties possessed by the different constituents in concealed ore bodies.

In this chapter we shall consider some actual examples of exploration surveys, both for petroleum and minerals, in which a combination of several geophysical tools has yielded useful and, in most cases, profitable geological information. In recent years, the literature of applied geophysics has contained an abundance of such examples in the form of case histories. In these, the geophysical results are presented in the form of maps or cross sections which can be compared with the geological picture as subsequently determined by drilling. A notable collection of such histories, all relating to petroleum exploration, is in the Society of Exploration Geophysicists' "Geophysical Case Histories," Vol. 1, published in 1949.

Significance of Case Histories

The case histories that have been published are not necessarily the best examples of successful geophysical exploration. There are perhaps more striking histories in the files of oil or mining companies which cannot release them because they involve areas which are still so active that the information in them might benefit their competitors. Security is almost as dominating a consideration in petroleum and mineral exploration as it is in warfare, and geological or geophysical data have a high security classification in areas where lease plays are still going on.

Published case histories almost always report instances where geophysical surveys have been successful. After studying them one might easily be misled into thinking that discoveries can be regularly expected in geophysical exploration. Unfortunately this is far from the case. A geophysical party may work full time for years before uncovering a prospect on which a discovery is made.

It is easy to see, however, that negative geophysical results can also be valuable. From reconnaissance surveys, they rule out areas which might otherwise be fruitlessly covered with more expensive detailed prospecting methods. They save the cost of drilling operations that might otherwise be projected on the basis of spurious surface indications or simply on hunch. Negative geophysical results may also justify the abandonment of leaseholds, with consequent large savings.

From case histories, the geologist is able to observe which types of geophysical measurement are most likely to detect different geologic structures of economic importance. A deep-seated salt dome can be expected to give only a weak gravity anomaly, but structures associated with the dome in overlying formations are frequently detectable by the reflection seismograph.

A magnetic survey would not be useful in petroleum exploration unless the oil trap is associated with a basement uplift or a serpentine intrusion. The best methods for any exploration project depend on the type of geology and the manner in which the material sought, whether oil or ore, is associated with the geology. It is difficult to plan a survey intelligently unless prior information is available on the geology of the area. In many cases, the geophysical survey itself is designed only to give geologic information which can guide further exploration.

A Case History Example

This example of a case history, taken from the S.E.G.'s case-histories volume, relates to the geophysical discovery of an oil field associated with a salt dome.

Lovell Lake oil field.—Lovell Lake field is near the Gulf of Mexico shore line, approximately equidistant from Beaumont and Port Arthur, being about 15 miles from each. It is near the southeastern corner of Texas. Although no salt has been reached by any of the borings in this area, the existence of a gravity minimum there indicates that the structure is associated with a deep-seated salt dome. The field is separated into two disconnected lobes by a normal fault 700 ft. in throw. There is a closure of 200 ft. on the downthrown side of the fault and one of 100 ft. on the upthrown side.

Geophysical exploration of various

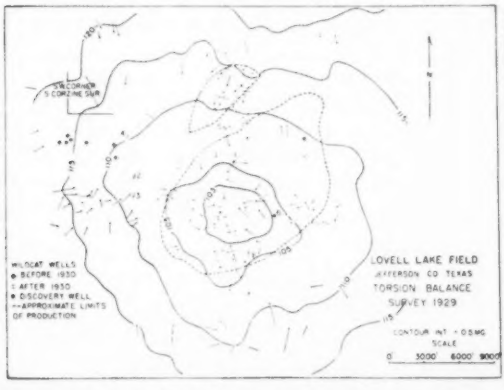

Fig. 41—Lovell Lake field. Gradients and contours based on gradient arrows. Dashed line shows present production. (After Wendler, reproduced from "Geophysical Case Histories," Vol. 1, by permission of S.E.G.)

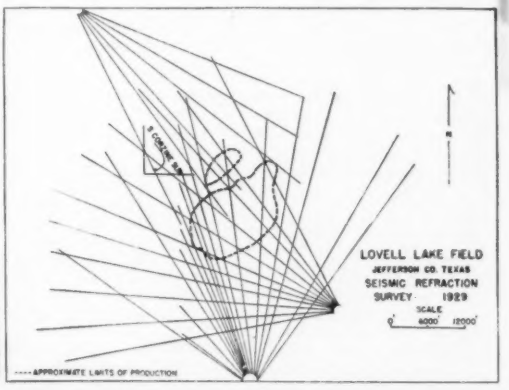

Fig. 42—Refraction fans for 1929 fan-shooting survey at Lovell Lake. No time leads were detected. (After Wendler, reproduced from "Geophysical Case Histories," Vol. 1, by permission of S.E.G.)

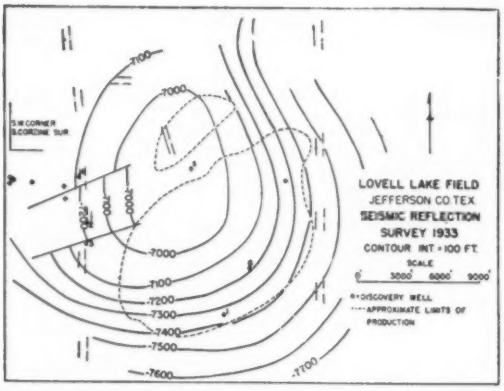

Fig. 43—Depth contours from first reflection survey at Lovell Lake field in 1933. Contour lines were based mainly on seismic dip data. (After Wendler, reproduced from "Geophysical Case Histories," Vol. 1, by permission of S.E.G.)

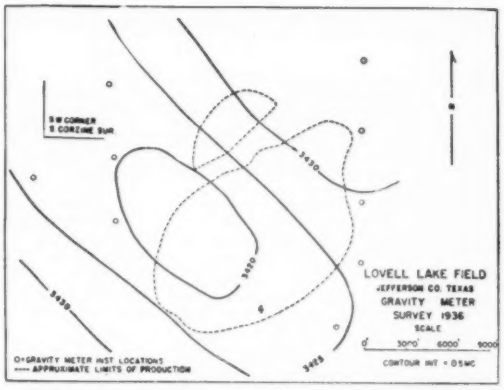

Fig. 44—Gravity contours over Lovell Lake field based on 1936 survey. Note approximate coincidence of gravity minimum and producing area. (After Wendler, reproduced from "Geophysical Case Histories," Vol. 1, by permission of S.E.G.)

kinds was carried on for 9 years over the present field before the existence of oil was established by the drill.

1. The close proximity of historic Spindletop field, only 3 miles away, led to the drilling of 8 dry holes before the first geophysical investigation, a torsion-balance survey, was carried out over the area in 1929. This revealed a gravity minimum of about a milligal, as shown in Fig. 41.

2. A refraction fan-shooting survey, laid out as shown in Fig. 42 and sponsored by Humble Oil & Refining Co. covered the area during the same year. There were no time leads. The lack of such leads over the area of the torsion-balance anomaly was explained on the assumption of a very deep salt dome.

3. In 1933, the first reflection survey was made of the area. The map which resulted is shown in Fig. 43. Both dip and correlation methods were used to construct the contours, which indicate a closed structure containing a graben. The assumption of a graben was based more on drilling information than on the seismic data.

4. Another and more detailed reflection survey was carried on in 1935. Two interpretations were made, one based on dips and correlation, the other on correlation alone.

At the time, the interpretation based on correlation alone and showing no faulting was favored over the other, which put a fault across the center of the area. The less-favored interpretation, however, was afterward found to be more correct when drilling had delineated the actual structure.

5. A gravimeter survey in 1936 indicated a minimum of about a milligal displaced about a mile from the earlier torsion-balance minimum. Fig. 44 illustrates this.

6. While this geophysical exploration of the area was going on, five dry wells were drilled, one of which (No. 1 of Fig. 43) turned out to be inside the producing area. The discovery well was drilled in 1938 at location No. 6. A reflection survey involving continuous profiling was undertaken by Humble immediately after the discovery, the purpose being to define the anomaly as closely as possible so that the results could be used to guide the choice of subsequent drilling locations.

7. Exploitation of the area (Fig. 45) showed that a reflection horizon bore a close correspondence in cross section to the producing sand. The displacement of the reflection marker because of faulting is dramatically indicated on one of the profiles by a jump in correlation within a single record.

Subsequent development.—By 1946, this field had produced some 10 million barrels of oil. In this year the average daily production from 100 wells was about 4,500 bbl.

Discussion.—Several conclusions can be drawn from this history. In the first place, a deep-seated salt dome can often give rise to a discernible gravity minimum where no time leads are obtained in refraction fan shooting. Secondly, the fact that five dry holes were drilled on the basis of geophysical indications before the discovery well was located indicates that persistence in continuing geophysical work and exploratory drilling can pay in spite of repeated early failures.

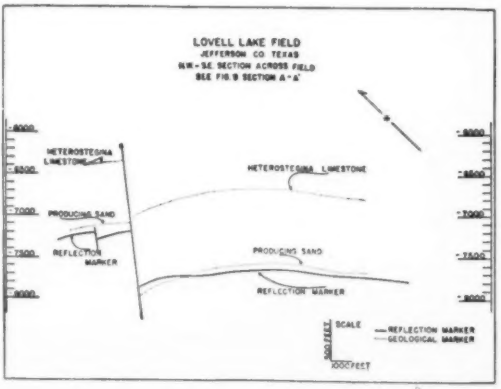

Fig. 45—Cross-section across Lovell Lake field showing reflection horizon and two known geological marker formations. (After Wendler, reproduced from "Geophysical Case Histories," Vol. 1, by permission of S.E.G.)

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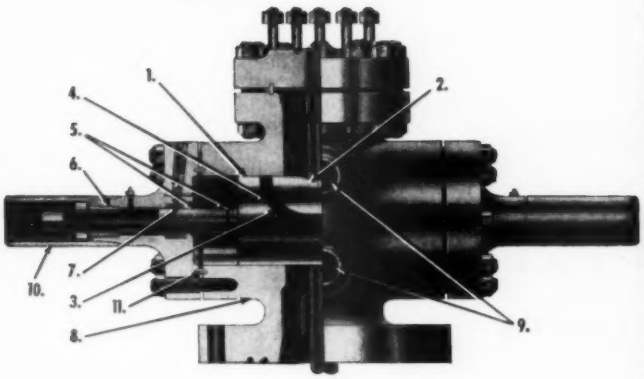

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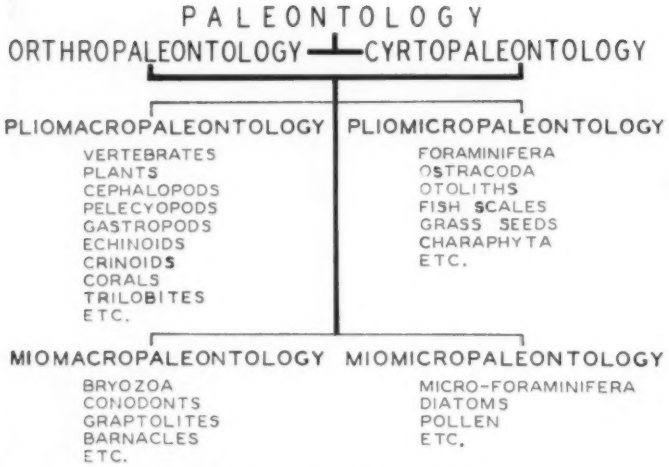

Fig. 1—Breakdown of the field of paleontology.

petroleum exploration between the geologist and paleontologist. Let us outline briefly (Fig. 1) the types of organisms that are being used currently in the field of paleontology. The field of orthropaleontology is restricted to the finding, naming, describing, and biological classification. On the other hand, we have the field of cyrtopaleontology wherein the paleontologist attempts to utilize the fossils. The cyrtopaleontologist is not interested in taxonomy; generally a letter or number will suffice for identification.

Most of our oil-company paleontologists fall in this latter group. The field of pliomacropaleontology includes most of the larger forms that have been studied in great detail by the orthropaleontologist. Most of these groups can also be found as smaller forms and herein would be classified as miomacropaleontology (Fig. 2). Many geologists and paleontologists recognize the latter groups as small, immature, dwarfed forms; however, I believe that many are fully developed, adult forms, and consequently a whole new subsurface field awaits investigation.

PALEOFACIES . . .

. . the geologist's new tool

by T. H. Philpott*

Present handling of data on changes in stratigraphic facies (paleofacies) could be vastly improved by combining cyrtopaleontologic and geologic information.

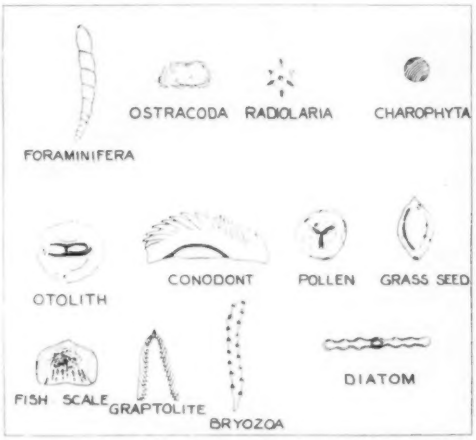

Fig. 2—Types of fossil organisms used by paleontologists.

THIS year marks the twenty-fifth birthday of the Society of Economic Paleontologists and Mineralogists. Within this quarter century, we have grown to a membership of 900 members. In spite of our small size, compared with the American Association of Petroleum Geologists and Society of Exploration Geophysicists we are making important contributions to the business of oil finding.

It has become increasingly apparent that our important petroleum reservoirs of the future will be controlled by porous limestones, terraces, and sand lenses, rather than faults and anticlines. It therefore follows that added variables which cannot be detected from the surface will, as Frank Morgan has stated, make the job of the exploration geologist in the future even more complex and costly. Obviously, a direct method of finding oil would solve our problems. A great deal of work and money is being expended currently in search of such a method. However, let us be realistic and leave this fantasy to the researchers. I recommend that we close the gaps in the oil-exploration ranks, using present techniques, assigning tasks of equal responsibility to the geologists, geophysicists, paleontologists, and mineralogists.

Kinds of Paleontologists

For a case in point, we must recognize that a large breach exists in our

Micropaleontology.—A similar division may be made in micropaleontology. Most of the forms being used today would be classified in the field of pliomicropaleontology. The importance of microforaminifers, diatoms, and pollen will be determined by future study and research.

Importance of Lithology

Generally speaking, a large part of the micropaleontological work being done today is based upon key fossils, that is, those widely distributed geographically and with a short stratigraphic range. This standard procedure omits a large and important element, together with the milieu (surrounding environments) from con-

*Stratigraphic-paleontologist, The Carter Oil Company, Shreveport, La. Retiring president of the Society of Economic Paleontologists and Mineralogists. Presidential address to the joint annual convention of A.A.P.G., S.E.G., and S.E.P.M., Los Angeles, March 24-27, 1952.

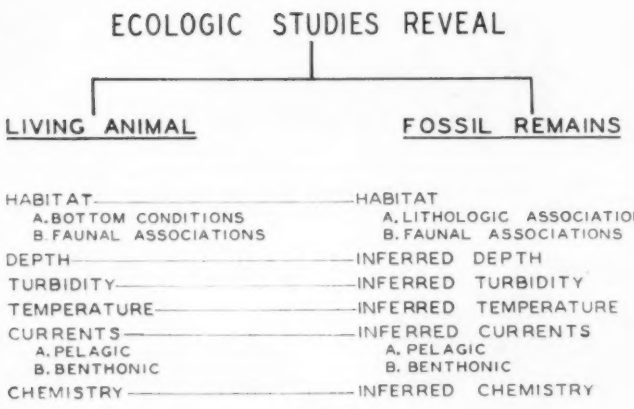

Fig. 3.

sideration in the over-all picture. On rare occasions, a small percentage of the microfaunal population is considered on the basis of abundance, the host rock, types, evolutionary development, or sequence. Single factors seldom are decisive, but a group of factors may lead to important solutions and conclusions.

Last year in St. Louis, the S.E.P.M. presented "A Symposium on Paleoecology of Shale and Evaporite Deposition." One of the participants, Samuel P. Ellison, Jr., pointed out that "workers in the field of micropaleontology have not consistently tied lithology and fossil occurrences together. Twenty-three per cent of the papers in the 11 volumes of the Journal of Paleontology 1940-50, failed to mention lithology. Such an item of omission is important to future writers and to future editors." An excellent example on how these data should be handled is shown by D. M. Loranger in "Useful Blairmore Microfossil Zone in Central and Southern Alberta, Canada" which appeared in November 1951 Bulletin of the A.A.P.G.

Ecologic studies.—Some research is being done today on the ecology of the living foraminifera. Important contributions have been made by F. B. Phleger, S. W. Lowman, M. L. Natland, and others. Lowman, Natland, M. C. Israelsky, and L. J. Wilbert have reported on investigations into paleoecology. Fig. 3 shows paleofacies or environment of the fossil remains that may be inferred from similar animals and plants living today.

Sample Data Handling

Let us review briefly the present procedures in subsurface geology. The samples are brought in from the field to the laboratory and after due processing, are turned to the paleontologist - stratigrapher. Normally the key or index fossils are reported to the subsurface geologist. This procedure is satisfactory where only structural prospects are being worked. If the information fits the general conditions, it is assimilated and used as evidence to support preexisting correlations. However, if it fails to support the geologist's ideas it is discarded.

Not all data utilized.—In the case of changes in stratigraphic facies, or paleofacies, the pertinent data are seldom reported or understood. In many cases the present handling of data could be vastly improved by having the cyrtopaleontologist combine his information with pertinent geological information. The subsurface and the administrative geologists should have a better understanding of the problems and information that the paleontologist can provide. Single geologic or paleontological factors are seldom decisive, but a better understanding of the biozone and its milieu may lead to solutions in oil exploration.

The number of examples that can be used is limited since one must refer to outcrop or cored sections. In the former case, the petroleum geologist is mainly concerned with key fossils that will help in structural interpretations. Insufficient cored sections are available at the present for use in conclusive paleofacies studies of the subsurface.

T. H. PHILPOTT

Classification of Environments

Some progress on the classification of marine environments has been made by the National Research Council's committee in a "Treatise on Marine Ecology and Paleoecology" under the chairmanship of H. S. Ladd. This committee's "Classification of Marine Environments" is based primarily on depth of light and proximity to shore. Obviously a thorough understanding of the neritic, bathal, abyssal, pelagic, oceanic pelagic, bathypelagic, and abyssolpelagic will yield pertinent data regarding paleofacies and oil accumulations.

Phleger suggests that temperature is a key factor affecting facies distribution and states that "Above this depth (80-120 m.) oceanographic conditions are strikingly different from those at greater depths. Average production of living benthonic foraminifera is approximately 10 times as great above 100 m. as at greater depths. Production rates and population census give a possible method for determining relative rates of sedimentation."

Time lines.—An understanding of paleofacies requires that time lines must be established. Israelsky has suggested that this may be accomplished by connecting points of deepest deposition. Paleofacies limits will cross time lines. Time lines may be constructed and correlations also may be made by following Israelsky's "Quantitive Micropopulation Analysis."

Examples of Paleofacies Studies

Attention is directed to the excellent work on faunas and facies in the Upper Eocene (Jacksonian Group) of Arkansas by L. J. Wilbert, coeditor of the Journal of Paleontology.

Wilbert states, "Differences in the conditions of deposition of the marl and arenaceous facies are strongly expressed in the faunas as in other sedimentary characteristics and both animal and sediments reflect the same ecological situation for each facies. Evidence indicates that the marl was deposited in marine waters of nearly normal salinity, whereas the arenaceous beds accumulated in water which was somewhat brackish, or which was, at least, measurably less saline than normal sea water.

"One clue to the ecological relationships between the facies is furnished by the absence of bryozoans, corals, and echinoids from the arenaceous facies. Most bryozoan, coral, and echinoid species are sensitive to variation in the salinity of the surrounding medium (stenohaline animals of ecologists), and exist only in waters

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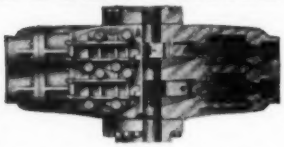

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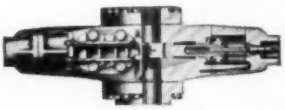

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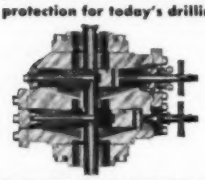

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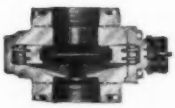

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having approximately normal salt concentrations (30 to 35 parts per thousand). The presence of these animals is, therefore, a good indication of normal marine salinity. Since they are found in the marl facies, deposition of the marl beds under normal marine conditions is indicated; conversely, their absence from the arenaceous sediments may mean that these deposits accumulated in water of reduced salinity."

As structural markers.—Let us next consider the Cook Mountain formation of the Claiborne group in Winn Parish of Central Louisiana. This formation clearly shows the marine advance with the Dodson member, marine biostromal development with the Milam followed by the deep cold water benthonic fauna of the Ceratobulimina eximia zone. The formation then becomes a regressive unit, characterized by the arenaceous fauna of the Little Natchez member. The top of the formation is not a reliable marker, but it would thus appear a reliable "time line" could be established in either Milam or the Saline Bayou members. Consequently these members are reliable structural markers.

The sediments of the Gulf Coast Tertiary are largely cyclical. The Cook Mountain formation represents the second marine invasion of the Claiborne group. The Claiborne fauna of Cane River age migrated southeastward from the Louisiana area during Sparta sand deposition. Although numerous new specimens evolved prior to Cook Mountain deposition, many species are common to both formations. It is difficult to subdivide the Lisbon formation with any degree or certainty, since the environment was virtually unchanged during middle and lower Claiborne time.

Aids history studies.—An interesting sidelight is the occurrence of Cyclammina caneriverensis in the upper Cane River. Normally the form would be observed as an arenaceous foraminifera. However, we find that most of the forms are distorted and twisted from their original shape. This is probably due to the early intense deltaic loading resulting from thick Sparta sand development. The paleontologist is therefore able to make a substantial contribution to the understanding of early Claiborne geologic history.

The Midway-Wilcox groups of Louisiana, Mississippi, and Alabama present a typical disagreement between geologists and paleontologists. The surface section of Sabine Parish, Louisiana, and Wilcox County, Alabama, may be correlated on the basis of Ostreatthirsae. G. E. Murray and E. Pitman have pointed out that the top of the Midway at the surface Sabine Parish is based also upon three diagnostic species of pelecypoda, seven species of gastropoda, and five species of foraminifera. However, below the top of the Midway as shown in Sabine Parish we find 700 ft. of sand, shale, and lignite. Even more section occurs in the subsurface of East-Central Louisiana and West-Central Mississippi. The obvious break to the geologist is at the top of the Porters Creek or the base of sand, shale, and lignites as mapped in the subsurface. A reasonable solution is to accept the faunal evidence as environment and use the top of the Porters Creek as a marked lithologic change.

Monroe "gas rock."—An interesting development in the Central Gulf Coastal plain is the "gas rock," a platform limestone deposit covering the Monroe and Jackson uplifts. It rests unconformably on early Upper Cretaceous, Lower Cretaceous, and Jurassic. Incidentally it forms a seal for Delhi oil pool where it overlies the basal Tuscaloosa sandstone.

Essentially gas rock consists of biostromal limestones that become biohermal over the positive features and clastic (arenaceous) in the basin areas. The faunal content of the gas rock consists largely of Orbitoididae. According to Cushman, "The orbitoides lived in shallow water at depths from tide level to perhaps 100 m. in a belt around the earth which included the tropical belt and the equatorial margins of the temperate belts."

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The Geologist and the Public

MAX W. BALL consultant, Washington, D. C.

MAN used geology for 100,000 years before he recognized it as a science or began to formulate its principles. The first man to find an eolith for use as a tool performed a geologic act. From his day to ours, man's progress has kept step with his blind or conscious, but ever-increasing, use of geology. Geology and the public welfare go hand in hand.

Is geology doing all that it could for public welfare in the United States? Could it contribute more than it now does to an enlarged economy, a higher standard of living, and national security? Every observant geologist knows that it could; he sees much that geology could and does not do. The reason lies in lack of public knowledge. The public knows little about the uses of geology or the usefulness of geologists.

The task of correcting this condition is ours. We, and we alone, can create a better-informed public. We face more than a task; we face a public duty.

As individuals, through our local and national societies, and through the American Geological Institute—the organization we have created to speak for all of us—we should tell the good that geology and geologists can do. We should see that the A.G.I. is better supported and more active.

Appalachia—A Land Mass

W. A. VER WIEBE, University of Wichita.

THE old land mass of Appalachia has never been precisely delimited or described as to lithology and topography. It has been shown on many maps as existing along the Atlantic seaboard, with somewhat indefinite borders. Barrell and also Schuchert were of the opinion that this land mass extended out to the edge of the Continental Shelf and even beyond that line. During the last decade modern students of geosynclines have shown a tendency to minimize its importance and its size. They have been guided in their thinking by the rather exhaustive studies of European geosynclines, in which it has been possible to crystallize out certain characteristics. In this manner ideas about eugeosynclines and miogeosynclines have been transferred to the Appalachian region.

On the assumption that the Appalachian geosyncline must have had a history similar to those in Europe, the land mass of Appalachia has suffered; almost to extinction. According to the latest concept among students of the Appalachian geosyncline, the lands which furnished the sediments for it consisted of a few long chains of volcanic islands. The author has felt for some time that these assumptions were not justified. A careful reading of all pertinent articles and books allows one to draw very definite conclusions.

First, a land mass existed which furnished enormous amounts of sediments to produce the rocks in the Valley and Ridge province. This land mass was very extensive and reached from Long Island southward as far as Florida. In width it spanned the distance between the edge of the Continental Shelf westward to the present position of the Blue Ridge anticlinorium. Naturally, the limits and the configuration of Appalachia changed considerably during the long time span involved in the Paleozoic era. During certain periods the size of Appalachia was considerably reduced. There were times when it was low and was overlapped by sediments from the west. There were other times, which can be sharply differentiated, when it was larger and when it was a rugged highland.

The evidence for Appalachia lies in the sediments derived from it. Therefore, the present article is a summation of all recent data on sediments in the Piedmont, the Atlantic Coastal Plain, as well as the fringe areas to the west and north of the Piedmont. Critical data on rocks and events in the southern part of New England were found to be particularly helpful.

Shallow-Water Sediments of the Northern Gulf of Mexico

FRANCIS P. SHEPARD, Scripps Institution of Oceanography, La Jolla, Calif.

A PROJECT of the American Petroleum Institute is being administered by several members of the staff of Scripps Institution with the advice of a committee headed by A. R. Denison for the purpose of studying the various shallow-water environments of deposition in the northern Gulf of Mexico. Field seasons have been conducted in two areas, one along the barrier island coast north of Corpus Christi and the other along the east side of the Mississippi delta. An intensive study is being conducted of the sediments, the biology, the chemistry, and the physical conditions of the areas. Experts from several universities and from several petroleum—company research laboratories are cooperating with Scripps Institute in the study of the information collected in the field.

Early results indicate that a large number of criteria can be used to indicate the environments in which ancient sediments have been deposited. Striking differences have been found between the protected environments of bays and the open Gulf. The faunal differences are particularly helpful; both macro and microorganisms show relations to the protection of the bays, to the lower salinites off river mouths, and to the channels giving ready access to the open gulf. The content of glauconite, faecal pellets, fine-grained calcium carbonate, abundance of oyster shells, of echinoids, of mollusks, and the existence of lamination are all features which are helpful in diagnosing the environment.

The general absence of a decreasing grain size outward from the mainland is strikingly illustrated by both field areas. The grain size of the sediment shows much more dependence on such factors as strength of current, exposure to large waves, and to the nature of sediments being introduced than it does to depth and distance from the mainland.

The rate of sedimentation, as might be expected, is proving to be very fast in much of the east delta area, with many feet of fill occurring in a few years, whereas in the Texas bays rates of perhaps a foot in a hundred years are suggested.

East of the delta the shelf is characterized by far less mud than to the west and by an easterly increasing content of calcareous sediments. The beaches, however, remain predominantly quartz sand along the entire west side of Florida.

Paleogeographic Significance Of Graded Bedding

Ph. H. KUENEN, University of Groningen, Netherlands.

DEEP-SEA bottom sampling and field work have both confirmed the explanation of graded bedding by the action of turbidity currents. Important paleogeographic conclusions can be drawn from the study of details. The association of coarse grain, ripple mark, current bedding, and shallow benthonic organisms does not supply proof of a shallow environment, because it can be produced in deep water by turbidity currents. Hence some geosynclinal series, hitherto considered of shallow origin, prove to be deep-water deposits. The type of grading and associated features may indicate either steep, moderate, or imperceptible slopes. In many cases the direction of the slope can be roughly determined or even accurately measured. This shows the direction of supply. A curious type of contemporaneous deformation (convolute bedding) is not uncommon.

Tertiary Basins of Southern California and Offshore Area

WILLIAM HENRY COREY, Continental Oil Co., Los Angeles.

SEVEN paleogeographic maps of this region are presented to show greatest sea extent during Eocene, Oligocene, Early, lower, middle, and upper Miocene, and Pliocene periods. A chart shows relative emergences and submergences of these time divisions. Another map shows basement areas known high at times in Tertiary, and probable ancient faults which controlled most sea margins.

Broad Eocene land and sea features were broken considerably by Oligocene regional emergence with deformations, but the general plan persisted into early Miocene, when regional submergence began. Transgression continued through Miocene, with a few interruptions, over an increasingly irregular terrain formed by a developing complex fault block pattern of basins and ranges. Great reversals of vertical relations between blocks, and great lateral offsets occurred over the region through Miocene and Pliocene. Many islands, land masses, and deep embayments were formed at different times, only to founder or be broken up. New general deformation ended Miocene, changing the plan with different Pliocene emergences, although many basins were deepened.

Marine sediments of the entire region, as a result of this post-Eocene changing geography, were mostly clastics from land, although thick deposits of organic nature formed over large areas during times of greatest submergence in middle and upper Miocene. Considerable nonmarine deposition went on in coastal valleys through Tertiary except in lower Pliocene.

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onshore paleogeographic study to the present submerged part of southern California. Interpretation of its history is provisional pending many geologic data and more knowledge of submarine processes. Meager data from this 15,000-sq.-mile area indicate the same structural and depositional histories there as in the smaller part of this Tertiary basin region now emerged. Offshore structurual features are much less eroded or obscured, and strata there probably are generally finer, thinner, and more organic.

Interpretive Stratigraphy Of the Great Basin

L. L. SLOSS, Northwestern University, Evanston, Ill.

A NUMBER of interpretations of Great basin stratigraphy have appeared in recent years and each has added to understanding of the area. None, however, satisfies all the known facts, and further modifications seem in order.

The present effort is based on an attempt to outline the tectonic behavior of the area with emphasis on the geographic and temporal diversity of tectonism expressed. Maps illustrating the thickness and character of major groupings of strata are interpreted to indicate major tectonic provinces within the Great basin area. From west to east, these previously recognized provinces are:

1. A eugeosynclinal trend with thick accumulations of internally derived clastics intercalated with volcanics and characterized by complex structure, varying degrees of metamorphism, and association with major plutons. The province is best exemplified by the Sierra Nevada-Cascade trend, but may at times have included a subsidiary from southern California through Central Nevada and Central Idaho.

2. A medial belt occupied by deeply subsiding basins which are filled with carbonates and clastics. The latter are largely derived from the continental interior to the east, occasionally from intrabasinal uplifts and from sources in the eugeosynclinal trend. The Oguirrh basin of eastern Nevada and western Utah dominates the basinal province.

3. A relatively stable province, barely represented in the Great basin region and marking the western limits of the Wyoming and Arizona shelves.

Intrepretation of the maps indicates very complex relations among these provinces with advancing geologic time. In general, there appears to be evidence for eastward expansion of the eugeosyncline at the expense of the basins and crowding of the latter against the stable shelves. It is suggested that continued eastward migration brought conditions which had prevailed in the Paleozoic and early Mesosic of the Great basin into the Rocky Mountains by Cretaceous and early Cenozoic.

The present hypothesis aids in understanding the anomalous Paleozoics of eastern Oregon and structural simplicity of the Snake River plain. It does not fully take into account the possible effects of later Tertiary movements and their displacement of sedimentary patterns.

Geology of Coastal Ecuador, South America, with Reference To Petroleum Deposits

CECIL HAGEN, consulting geologist, Houston.

THE paper is limited to the geology of that portion of Ecuador adjacent to the Pacific Coast. Parts of this area have been described in earlier articles but this is believed to be the first to cover the entire coastal belt, extending 400 miles from Colombian to Peruvian borders.

The sedimentary strata are Upper Cretaceous, Tertiary, and Recent deposits, interrupted by a few local volcanic intrusions. The greatest amount is Tertiary, ranging in age from middle Eocene to upper Miocene and having a composite thickness of over 50,000 ft. These beds are predominantly marine and composed of sands, sandstones, shales, and occasional limestone beds. The Cretaceous is mainly limestones, cherts, and reworked volcanics.

Structurally there is a series of positive and negative areas, with the former being adjacent to the coast line. There are three sedimentary basins: Progreso basin in the south, Jipijapa-Quininde basin in the central portion, and Borbon basin on the north. Faulting is present in all areas, some with considerable horizontal and vertical displacement.

Depositional and structural history are clearly evident in the rocks. Both phases have been governed by the adjacent Andes Mountains and Pacific Deep.

The proven petroleum deposits of Ecuador are confined to the Santa Elena Peninsula. Production is from the Socorro and Atlanta formations of the middle Eocene. In addition there is shallow pit production. Accumulation is caused by a combination of structure and stratigraphy.

Coral Reefs of Australia

CURT TEICHERT, University of Melbourne, Australia.

AUSTRALIA is rich in coral reefs which line its coasts for about 4,000 miles. The Australian reefs are of singular importance to the stratigraphic geologist, because:

1. They grow on continental shelves in what may be called a normal geological environment.

2. They lie entirely outside the belt of Tertiary orogeny and of recent tectonic activity, volcanism, and seismicity. They have grown since the Pleistocene on essentially stable foundations.

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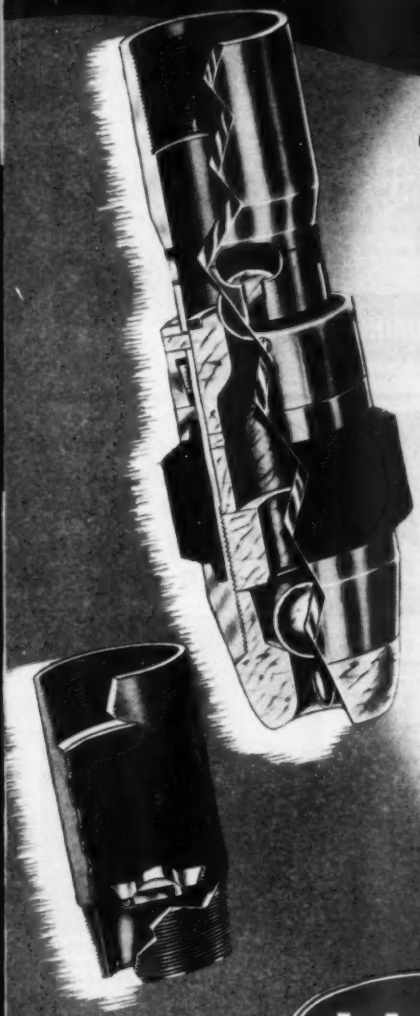

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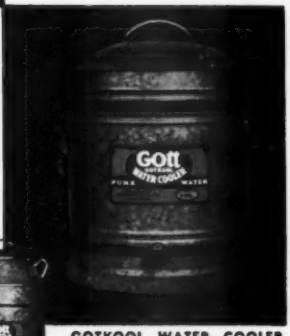

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coasts of the most varied geological structure and along which a wide range of physiographical processes are in operation. It is not surprising, then, that among the reefs of Australia we find a greater variety of reef types than among any other geographically connected group of reefs in the world.

Fractured Reservoirs . . A Symposium

Fractured Shale Reservoirs Of California

L. J. REGAN, JR.

IN California there are two regions in which fractured sedimentary rocks form important oil reservoirs. They are the Santa Maria Coastal district and the southwestern portion of the San Joaquin Valley. This type of reservoir rock is limited to fractured chert and siliceous shale of upper Miocene age.

The productive areas, areal distribution, thickness, and lithologic variations of these strata are illustrated by two maps and seven stratigraphic sections. The sedimentary history and mode of origin of the fractures in the cherts and siliceous shales are discussed.

The general characteristics of the fractured rock reservoirs are described and factors bearing on reservoir performance and determinations of recoveries are considered.

Dynamic Role of Dilatancy in the Migration and Accumulation Of Oil in Metamorphic Rocks: A Hypothesis*

DUNCAN A. McNAUGHTON

DIFFICULTIES inherent to the prediction of potential reservoir conditions in basement rocks buried by a concealing mantle of sediments are apparent to all geologists and constitute the main cause for prejudice against basement exploration. Consequently geologists have not played an important role in the discovery of oil accumulations in basement rocks. All the major discoveries have been accidental.

Our record can be improved by a critical examination of our working hypotheses concerning the nature of the geological processes responsible for the formation of basement oil pools. Among these hypotheses is the generally accepted "up slope" theory of oil migration in basement reservoirs. The theory is closely patterned after our working concept of migration of oil in conventional sandstone carrier beds. The theory and its limitations as a guide for exploratory work are discussed.

An alternative proposition is advanced that fracturing of competent basement rocks involves dilatancy which in turn reduces hydrostatic pressures in focal areas of deformation. Pressure gradients are thereby established between the potential basement reservoir rocks and the overlying source and carrier beds containing oil, gas, and water. Thus a tendency to "suck in" fluids into the basement rocks is established. The hypothesis appears to be compatible with the field evidence in several basement oil pools in southern California.

*Published by permission of the chief geologist, Western Gulf Oil Co., Los Angeles.

Fracture Controlled Production in Gilbertown Field, Alabama

JULES BRAUNSTEIN, Shell Oil Co., Jackson, Miss.

GILBERTOWN field is located in Choctaw County, southwestern Alabama. The major production is obtained from Eutaw (Austin age) sands in traps along the upthrown side of an east-west fault system. Production is also derived from the overlying Selma chalk (Navarro and Taylor age) on the downthrown side of the faults, from a fractured zone coincident with or just above the fault plane. Regardless of its relative structural position, no porosity has been found; hence, no accumulation of oil occurs at Gilbertown in the Selma section where it has not been cut by a fault.

Oil from Fractured Shale Reservoirs in Colorado

Research Committee*, Rocky Mountain Association of Geologists.

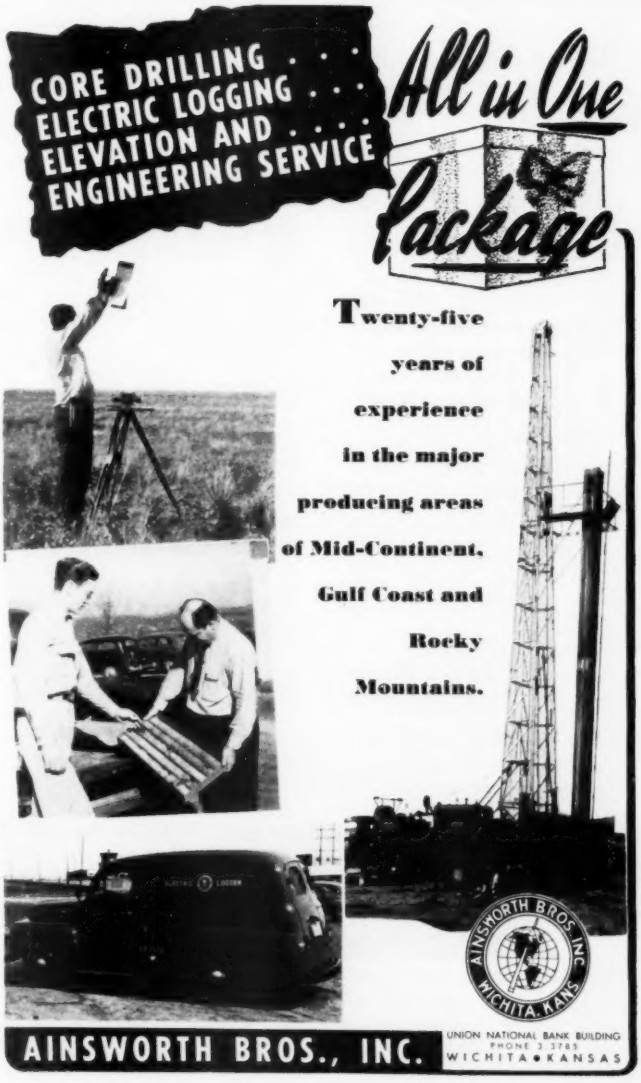
FLORENCE-CANYON CITY, Tow Creek, Rangely, and Boulder oil fields are typical examples of Colorado pools which produce from fractured shale reservoirs. Oil production is from the Pierre or Mancos shales of Upper Cretaceous age or their correlatives. In some of the fields, the fractures which form the reservoirs are partly filled with calcite. At Rangely, numerous outcropping calcite veins characterize the area of best oil production.

*GEORGE R. DOWNS, Carter Oil Co., Denver; N. WOOD BASS, U. S. Geological Survey, Denver; JOHN H. MAXSON, Aerial Exploration Co., Denver; ALEX W. McCOY III, Gulf Oil Corp., Tulsa.

Evidences of Fractured Reservoirs in Wyoming

H. DONALD CURRY, Shell Oil Co., Casper, Wyo.

IN the majority of oil and gas fields in Wyoming the producing reservoirs have relatively low interstitial porosities



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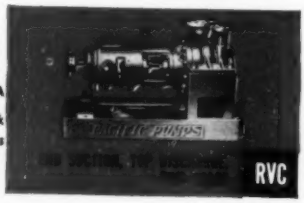

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and permeabilities, as compared with those of most oil-producing regions. In many of these reservoirs fracturing can be shown to be present and to exert a beneficial effect upon productivity.

Criteria indicative of fracturing are discussed and data on the various fields are listed in tabular form. A classification of the fractured reservoirs into four separate categories is attempted and examples of each category are described in some detail.

Fracturing in the Spraberry Reservoir, West Texas

W. M. WILKINSON, Sohio Petroleum Co., Abilene, Tex.

THE Spraberry formation of West Texas is developed in the lower Leonard of Middle Permian, restricted in most part to the Midland basin. The main producing structure is a fractured permeability trap on a homoclinal fold. This homogeneous mass is undifferentiated except as to alternate layers of sands, siltstones, shales, and limestones, deposited in a deep basin under stagnant conditions with hydrocarbons formed throughout the 1,000 ft. of sediments.

Fractures were created by tensional forces after induration, probably during post-Leonard time. With storage of the oil reservoir in the sandstone matrix, the fractures serve as "feeder lines" to conduct the oil to the bore hole. Without these fractures it would be difficult to obtain commercial production from a seemingly "too-tight" reservoir rock.

Spraberry production is obtained in a fairway 150 miles long and 50 miles wide at an average depth of 6,800 ft. The main producing area, however, is 50 miles long, with width ranging from a few miles to 18 miles, thus creating a triangle of 480,000 proven and semiproven productive acres.

Mississippian "Chat" Production In East Central Kansas

EDWARD A. KOESTER, consulting geologist, Wichita.

OIL and gas production from Mississippian chert is found over several counties in East-Central Kansas on the west flank of the Nemaha "granite ridge." This report covers several oil pools in Marion, Dickinson, and Morris counties, grouped together as the Lost Springs district.

Commercial production was discovered in 1928 in Township 17s-4e and development has continued irregularly up to the present time. Production has also been found in Township 16s-4e, 16s-5e, 17s-5e, 18s-4e and 19s-4e. About 638 wells have been drilled, including wildcats in the mapped area, of which 343 or 55.3 per cent have produced oil or gas. Cumulative production has been about 9 million barrels of oil. Nearly all the development has been done by independent operators.

Upper Permian rocks outcrop throughout the area and have been used to outline the surface structures. There seems to be an indefinite relationship between productive areas and surface "highs."

Top of the Mississippian system is reached at depths of 2,200 to 2,500 ft. The producing rocks consist almost altogether of chert which apparently represents the leached cherty limestones of the Osage group. Oil production is not found at any uniform penetration of the chert. In many wells, water is found above the "pay." Water also may be found with the oil or below it, but there is no general water drive apparently, except possibly on the western downdip side of the district. The relationship of gas to oil also is irregular.

Fractures cannot be proved but are believed to play an important part in the production of oil from these rocks. Cores are generally unavailable but samples of the producing part of the Mississippian rocks differ little from the nonproducing part. Tripolitic chert appears to be more favorable for production than fresh chert but neither show much porosity or more

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than a small amount of strain. Free oil is seldom seen in washed rotary samples although it may be abundant in unwashed samples. Likewise, no odor may be detected in samples of some productive beds. Individual well performances vary considerably. Flowing wells may be offset by dry holes. Bottom-hole pressures appear to be erratic.

Fractured Nature of West Edmond Hunton Reservoir, Central Oklahoma

ROBERT MALCOLM SWESNIK, General American Oil Co. of Texas, Dallas.

WEST Edmond oil field, Central Oklahoma, discovered in April 1943 had produced to January 1952 approximately 93,000,000 bbl. of oil from a total of 750 Hunton lime wells. Current daily production is 7,000 bbl. of oil and 9,000 bbl. of water, the latter being returned to the reservoir.

As early as August 1945 the author suggested the Hunton reservoir contained a network of interconnected solution enlarged fractures, together with the intercrystalline and intergranular porosity of the limestone. In June 1946 members of the geological and engineering department of Gulf Oil Corp. prepared a report entitled "A Reservoir Study of West Edmond Hunton Pool," wherein from very detailed examination of available cores, quantitive estimates of the amount of pore volume in the fracture system was estimated. The presence of the fracture system was also inferred from the producing characteristics of the reservoir.

This work was later amplified by Littlefield, Gray, and Godbold, in their excellent paper published in December of that year. They estimated 10 per cent of the pore volume was contained in the fractures. At this early date not enough production history was available to substantiate the fracture theory, and several engineers did not accept it. Now after almost 9 years of history, in the twilight of the pool's life, the fracture theory is generally accepted as fact.

Oil Production from Fractured Pre-Cambrian Rocks in Central Kansas

ROBERT F. WALTERS, Walters Drilling Co., Inc., Wichita.

FRACTURED pre-Cambrian basement rocks are the reservoir from which over a million barrels of oil have been produced in the Orth field, Rice County, Kansas, from 15 wells. Similar fractured quartzite is the reservoir from which oil is produced in four wells in the Kraft-Prusa field, and from one well each in Beaver, Bloomer, Eveleigh, and Trapp fields, all in Barton County. Fresh pink biotite granite is the reservoir rock producing oil in three wells in Hall-Gurney field and in one well in Gorham field, both in Russell County. A few other wells not investigated by the writer, are reported to be producing from pre-Cambrian rocks.

All wells known to be producing from pre-Cambrian rocks are located on the summits of buried pre-Cambrian hills. Porosity consists of a reticulated fracture system. The pre-Cambrian reservoir rocks are unconformably overlapped by Pennsylvanian limestones draped above the hills in gentle anticlinal folds which trap oil in multiple thin porous zones in the Topeka (Virgil) and Lansing-Kansas City (Missouri) limestones. Pennsylvanian rocks are considered as the probable source from which oil migrated locally into the fractures in the pre-Cambrian rocks. Truncated Cambro-Ordovician Arbuckle dolomites, themselves an oil reservoir, are present on the flanks of each hill and are a less probable source from which the oil in the pre-Cambrian reservoirs was derived.

It is the writer's opinion that the fractured pre-Cambrian rocks have been inadequately tested as to their porosity and fluid content. It is suggested that the pre-Cambrian basement rocks, when encountered structurally (or topographically) high in future drilling in Central Kansas, are worthy of careful consideration as a potential oil reservoir.

End of Symposium

Seismic Recording on Magnetic Tape

G. B. LOPER and R. R. PITTMAN, Magnolia Petroleum Co., Dallas

A system of recording and reproducing exploration seismograms on magnetic tape is described. Geophones and amplifiers with broad band response, approximately 4-300 cycles per second, are used to channel the seismic signals to a 13-track tape recorder. The magnetic tape is 1-in. wide. Some narrowing of the band width at both high and low-frequency ends is done to suit the particular studies to be made. One of the tracks is used to record a time reference signal. Each broad band recording is formed into an endless loop and played back in repeating fashion. The signals are fed through a flexible system of filtering and mixing, then examined on the screen of a 12-trace cathode-ray oscilloscope of 12-in. diameter. The sweep of the oscilloscope is synchronized with the loop and, by varying the sweep speed, the entire record, or an expanded portion thereof, is held stationary on the screen. Conventional paper records of the reproduced, modified record are finally made with a regular seismic camera.

Gulf Airborne Gradiometer

W. E. WICKERHAM, Gulf Research & Development Co., Pittsburgh

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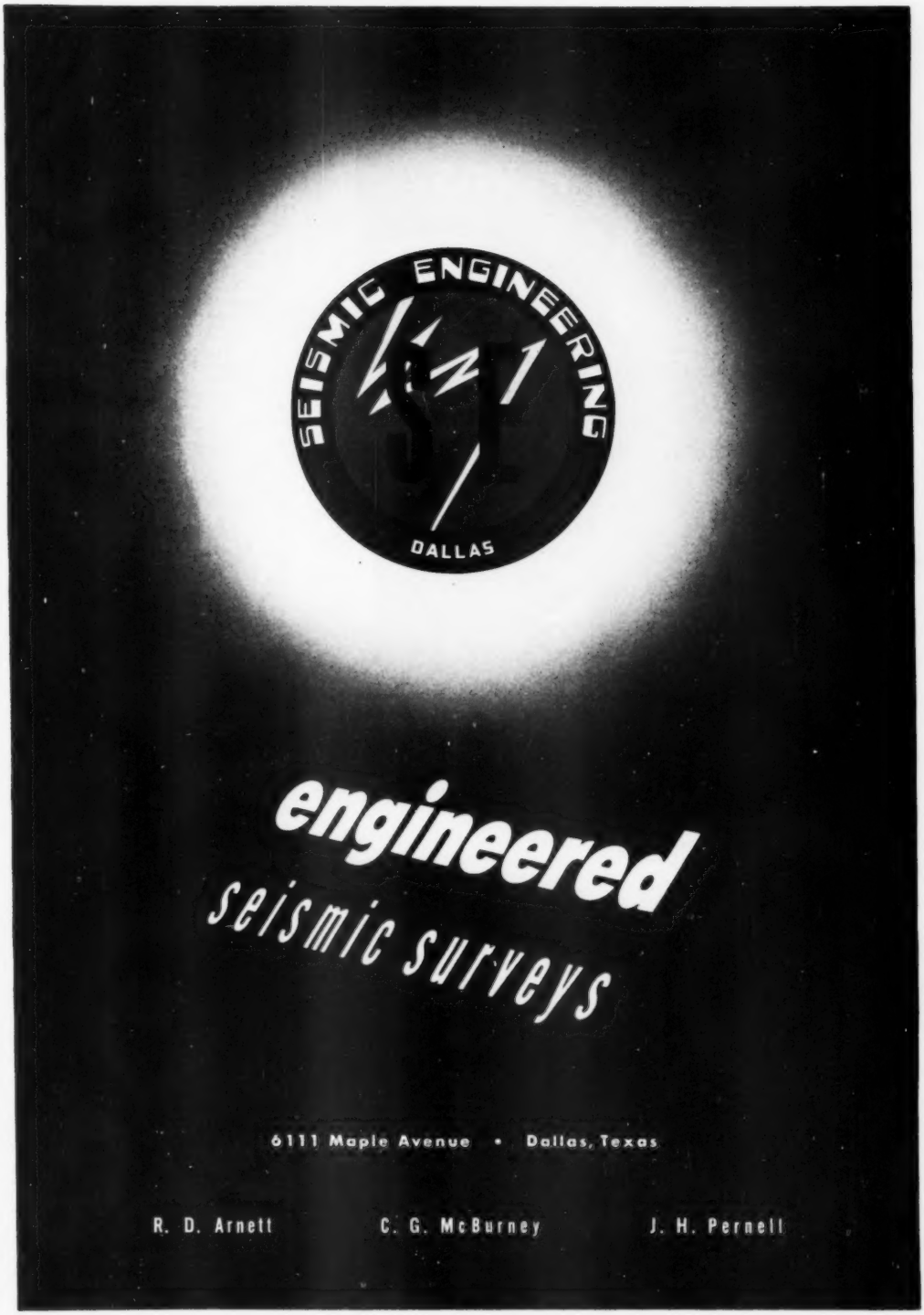
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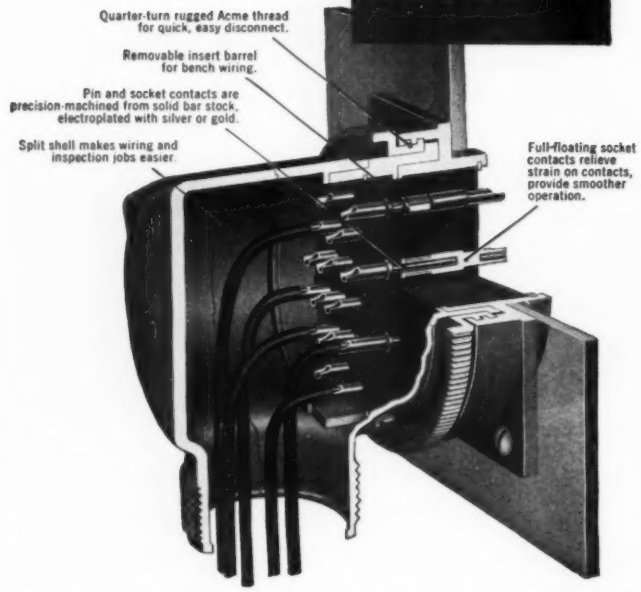
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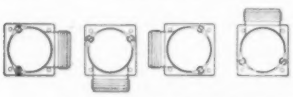

Diagram at left shows how the four positions of cable entry on the large 90° "K" endbell make the wiring job easier. Smaller Type "K" connectors have three positions.

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usefulness, particularly for qualitative analysis, will be discussed briefly. The design of a spatial-type airborne gradiometer of adequate precision can be shown to be quite impractical. An instrument based on the time derivative of the magnetic intensity variations provides a useful alternative and will be described.

Some Important Problems Concerning World-Wide Gravity Program

W. HEISKANEN, Finnish Geodetic Institute and Ohio State University, Columbus

THE principal geodetic purposes of the world-wide gravity program are: to convert the existing geodetic systems into one uniform World Geodetic System; to determine the shape of the geoid; and to check the dimensions of the reference ellipsoid with the help of the existing triangulation methods.

Work done during the past year will be reported and an outline given on what has yet to be done to successfully complete the program. Special mention will be made of the significance of the gravity measurements at sea; of gravity surveys in some unsurveyed areas; of the most useful reduction of gravity anomalies; and of the connection of the gravity base stations of the world to the same system. The ultimate result of the world-wide gravity study will be discussed.

Basic Principle of La Coste-Romberg Underwater Gravity Meter

LUCIEN LA COSTE

THE large seismic motion encountered at the bottom of the ocean—often as much as ⅛ in.—prevents the use of an ordinary land gravity meter (with remote operating and indicating devices) from being used for underwater work. The beam hits the stops which are necessary to prevent large errors from hysteresis.

The La Coste-Romberg underwater instrument meets this difficulty by means of a servo-driven elevator which automatically raises and lowers the whole meter so as to prevent the beam from hitting the stops. This is done in such a manner as to keep the elevator oscillating about a central position so as not to add any net acceleration to the beam reading. An electrical circuit averages the position of the beam, and readings are taken by nulling this average. Readings can be obtained with an accuracy of 1/10 milligal even when the ocean bottom is undergoing vertical seismic motion with a double amplitude of ⅛ in. and a period of 4 seconds. A basic patent has been allowed by the U.S. Patent Office.

Procedures for Direct Employment Of Neutron Log Data in Electric Log Interpretation

M. R. J. WYLLIE, Gulf Research & Development Co., Pittsburgh

IT is well known that under suitable borehole conditions there is a relationship between porosity and the deflection of a neutron-log curve. This relationship finds practical use, calibration of the neutron deflections being made by reference to porosities measured on cores. It is shown that core analysis is not mandatory for neutron log calibration and that the calibration may be achieved by direct plotting of suitable neutron and electric log data.

For this purpose the concept of the neutron deflection corresponding to a formation factor of unity is introduced. It is shown that this concept makes it possible to use directly combined electrical and radioactivity logs to locate zones of saturation in hard rock formations and even to make estimates of the hydrocarbon saturations. Application to sandstones is also considered.

In oil-base mud logging, neutron-log data may be conveniently combined with induction-type electrical-log resistivities to give

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information bearing on the location of hydrocarbon saturation and the estimation of connate water salinities. Finally a combination of electrical and radioactivity log data is theoretically capable of contributing to the quantitative elucidation of the "dirty sand" problem.

Evaluation of Density Data for Determination of Density Contrasts

RAOUL VAJK, Standard Oil Co. (N. J.)

DENSITY values determined on scattered cores of a well are not sufficient for locating density contrasts in sedimentary strata. However, they can be used for constructing a curve representing the density of shale (or marl) as function of depth. From this curve missing density values of shale can be interpolated. Density values of other alternating sedimentary beds, as sand, sandstone, limestone, etc., do not change considerably with depth and a few density determinations on these samples should be sufficient.

Analysis of Accidents Reported to Accident Exchange Group in 1951

H. M. THRALLS, Seismograph Service Corp., Tulsa

STUDY of the accidents reported monthly to the Accident Exchange group reveals a monotonous repetition of a number of accidents month after month. They are repeated with such regularity that it is almost possible to predict the number of wrecked shooting trucks, the number of mashed fingers, and the number of cases of poison ivy that will be reported the following month. Such information, if used properly, could be used to eliminate a high percentage of the expectable injuries. This conclusion seems valid because the greatest hazard in seismograph work, dynamite, is responsible for very few accidents. Dynamite is the one hazard upon which accident-prevention efforts have been concentrated.

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Experimental Well Velocity Results Using a Jet Perforator

MAURICE SKLAR, Union Oil Company, Bakersfield, Calif.

AN experimental velocity survey has been made in a 7,200-ft. core hole in Ventura County, California, firing charges from a McCullough Tool Co. Jet Perforator lowered into the hole at various depths and observing travel times to geophones on the surface. Number and size of the charges fired simultaneously varied from 2 of the 16-g. size to 28 of the 90-g. size. Energy was ample at all depths, although for the 7200-ft. shot it was necessary to estimate the first-arrival time from later phases. Upper portion of the survey made when the hole was 913 ft. deep, was duplicated by the conventional method of lowering a geophone into the well and shooting in shotholes 90 ft. from the well. Comparison of results indicates that all first breaks recorded by the conventional method were transmitted through the geophone cable except when the geophone was set on the bottom of the hole.

Effect of Saturation on Dilatational Wave Velocity in Rocks*

D. S. HUGHES and J. L. KELLY, Department of Physics, University of Texas, Austin

THE velocity of dilatational waves in four sandstones and a shale has been measured in the laboratory by high frequency pulse methods previously described. The velocity was measured in both dried and water-saturated cores for each rock.

At atmospheric pressure the change in velocity with saturation is not very great but with most specimens the velocities in the saturated rocks are definitely higher. With increase in hydrostatic pressure the saturated cores show relatively little increase in velocity whereas the dry cores show relatively large increases in velocity. For the samples studied at the upper pressure limit of 1,000 bars (15,000 psi.) the dry velocity is always greater than the saturated velocity. The sandstones used are from widely spaced localities and have porosities in the range 8 to 20 per cent. The hydrostatic pressures were held to 1,000 bars to reduce irreversible alteration of cores. These results are compared with past measurements and possible origins of disagreement are discussed.

*This work was supported by the Office of Naval Research under Contract N6onr-266, Task Order VIII, and by research grants from Shell Oil Co. and Humble Oil & Refining Co.

Significance of New Research On Foraminifera

FRED B. PHLEGER, Scripps Institution of Oceanography, La Jolla, Calif.

RECENT research on Foraminifera is discussed from the point of view of its usefulness in sedimentology and stratigraphy.

Work on ecology of Foraminifera has produced some knowledge of the following. (1) depth zonation of benthonic forms, (2) definition of many details of the nearshore faunal distributions and environments, and (3) additional inforamtion on the ecology of planktonic forms. These re-

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sults are applied to understanding marine processes and can be applied to understanding older environments and predicting sedimentary patterns.

The importance of planktonic Foraminifera in stratigraphic correlation has been demonstrated during the last few years, and this can assist in providing a chronologic framework for more detailed investigations.

Geophysical Exploration In the San Juan Basin

NEAL CLAYTON, Century Geophysical Corp., Tulsa

A general discussion of the problems encountered in making geophysical surveys in the San Juan basin. Magnetometer and gravity surveys are complicated by the extreme topographic relief and the presence of Tertiary intrusives. Seismic surveys are hindered by the scarcity of water for drilling. Housing for all geophysical crews is a major problem. Adequate velocity and well control are lacking in most parts of the basin.

Transformations of Organic Matter In Recent Basin Sediments

S. C. RITTENBERG and K. O. EMERY, University of Southern California, Los Angeles

THE depth distribution of nitrogen and carbon and associated parameters in basin sediments was determined by analysis of a series of cores taken from approximately the deepest point of the 13 basins off the coast of southern California.

Both organic carbon and organic nitrogen decrease with depth of burial, but nitrogen decreases faster than carbon with the sharpest decline in the top few inches of sediment. Little change occurs in nitrogen content or carbon-nitrogen ratio between a depth of 5 ft. in the sediment and 6,000 ft. in the shales of the Los Angeles basin.

The constancy of the carbon-nitrogen ratio at depth is attributed to lack of bacterial activity owing to absence of oxygen, to the more resistant nature of the remaining organic matter, and perhaps to other unknown factors. On the basis of estimates for annual production of organic matter in the waters overlying the basins and losses in organic matter in the water and sediments it is estimated that only 1 bbl. of oil is recovered from solar energy equivalent to about 6 million barrels.

Some Southern California Shelf Sediments

K. O. EMERY, University of Southern California, Los Angeles

THE Continental Shelf of southern California is only 1 to 12 miles wide and is separated from the continental slope by a series of basins, banks, and islands that belong to the continental borderland.

The shelf sediments have been studied in four of the widest places, near the cities of San Diego, San Pedro, Santa Monica, and Santa Barbara. Some of the sediments are detrital, mostly submarine extensions of beaches and deposits of mud in areas of relatively quiet water. Other sediments are residual and derived from weathered rocks or poorly consolidated strata that crop out on the sea floor. Organic sediments, composed of shell fragments and foraminiferal tests, make up a small to large percentage of the whole sediment. Small quantities of authigenic sediments consist of glauconite and phosphorite. Lastly, a fossil type is formed by normal shelf or beach sediments deposited when sea level was somewhat lower than now but not yet buried beneath present sediments.

Each of these five kinds of sediment may dominate in a particular part of each shelf area. Their pattern in ancient or other present-day shelf sediments should be indicative of some of the environmental conditions, but the complexity of origin and distribution requires some care for proper interpretation.

Fossil Fish Scales in Exploration For Petroleum

W. T. ROTHWELL, Richfield Oil Corp., Long Beach, Calif.

FISH scales are useful stratigraphic markers because they are abundant, convenient in size, distinct in identifying characters, and are not crushed by compaction. Fossil scales clearly reveal the pure or mixed source environments which have contributed to a sediment. A shale formation may contain a mixture of scales from several life regions of the sea. Scales of oceanic surface feeders commonly occur with those of abyssal fish, and rock fish may be represented along with the migratory shad and salmon.

Scales vary greatly in shape over the body of a live fish. The range in outline and other morphological characters in scales of related living species may overlap. Thus, it is important for the worker to have a large collection of Recent scales at hand. Some unrelated fish have similar scales. The arbitrary fossil scale groups based on fossil types used by the author, are believed to be of generic or family rank. The complete skeleton—rare in well cores—is the soundest basis for speciation.

Correlations over a distance must be analyzed carefully because fish are sensitive to their environment and the scale fauna reflects facies change. Successful results are obtained in stratigraphy, where other fossils fail, by detailed quantitative logging of scales in well cores or outcrops of each local area. Each formation carries its characteristic scales. They reveal the hiatus, unconformity, and change in depositional history. Along the Pacific coast

(Continued on page 212)

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Geophysical Exploration Comes of Age

by Sigmund Hammer*

The author looks at this comparatively new profession, reviewing briefly its past, and venturing a glimpse at what may lie ahead

MY title, "Geophysical Exploration Comes of Age," has been chosen to commemorate the twenty-first anniversary of the society which I have the honor to represent at this great meeting. Another birthday is not, of itself, an event of any particular importance. On the other hand, the twenty-first birthday of an organization, as well as of an individual, has traditionally been the time to stop to review the past, to take stock of the present, and to consider the prospects for the future.

Following this precedent, I shall atttempt (1) to review the growth of geophysical exploration, particularly in the United States but not ignoring foreign developments; (2) to point out where geophysical exploration stands today; and (3) to try to peer into the future to catch a glimpse of what may lie ahead.

SIGMUND HAMMER

A Young Science

In terms of the history of science and technology, geophysical prospecting is very young. It is true that important deposits of iron ore were discovered by magnetic surveys as long ago as 100 years. But we need not stop to consider that ancient phase. The modern age of geophysical prospecting can fairly be said to have begun in 1915 when an Eotvos torsion-balance survey successfully extended the deep flanks of the Egbell structure in Czechoslovakia.† This was apparently the first deliberate application of geophysical prospecting, in the modern sense, to oil finding. As we all know, this is the fertile field in which the geophysical prospecting science has flourished and grown to its present stature of world-wide industrial importance.

It is of interest to point out that the idea of applying geophysical measurements in search for oil could hardly have occurred much sooner because, according to DeGolyer,‡ the year 1913, only 2 years earlier, marks the beginning of the acceptance of geology as a guide to prospecting.

All of us realize how vast is our present profession. Few realize how quickly, in how very few years, it has developed.

The history of the development of geophysical exploration is very intimately related to the history of the Society of Exploration Geophysicists. Seismic and gravity crews were brought from Germany to the Gulf Coast in the early 1920's to aid in the search for salt-dome oil fields. The spectacular success of these early geophysical surveys is well documented in published articles, textbooks, and technical monographs. But, the first flush of success faltered.

Birth of S.E.G.—It became necessary for two, heretofore almost unrelated, scientific disciplines, geology and geophysics, to merge their thinking, to work together for further progress. And so it came about, in 1930, that a group of geologists and geophysicists who recognized the close interdependence of their problems, the need for the interchange of ideas, formed an organization for the express purpose of developing and improving geophysical techniques in the search for oil. Appropriately enough, the first meetings were held in Houston, the center of geophysical activity at that time.

The name chosen for the organization was the Society of Economic Geophysicists. The list of charter members includes 46 names, among them such well-known geologists as Alexander Deussen and Donald C. Barton. Today the membership approaches 3,000 in 41 states and 49 foreign countries. There are nine local sections and three student sections. Four additional sections are in process of formation and affiliation in the United States and abroad. The society's magazine Geophysics has world-wide circulation.

The scope of professional interest embraces all problems related to the scientific exploration for mineral resources of all kinds in the earth's crust. This broad scope was clearly envisioned by the founders of the society as indicated by its first name. However, for reasons which are not now apparent, the name was changed a year later to the Society of Petroleum Geophysicists. Five years later, realizing that the limitation in scope implied by this name was undesirable, the present name was chosen: the Society of Exploration Geophysicists. With this name, we have now lived 15 years and have fond hopes of living happily forever after.

The Society of Exploration Geophysicists is affiliated with the American Association of Petroleum Geologists, under whose motherly wings it nestled in the first few years of its existence. It is also a member society of the American Geological Institute.

Present Economic Stature

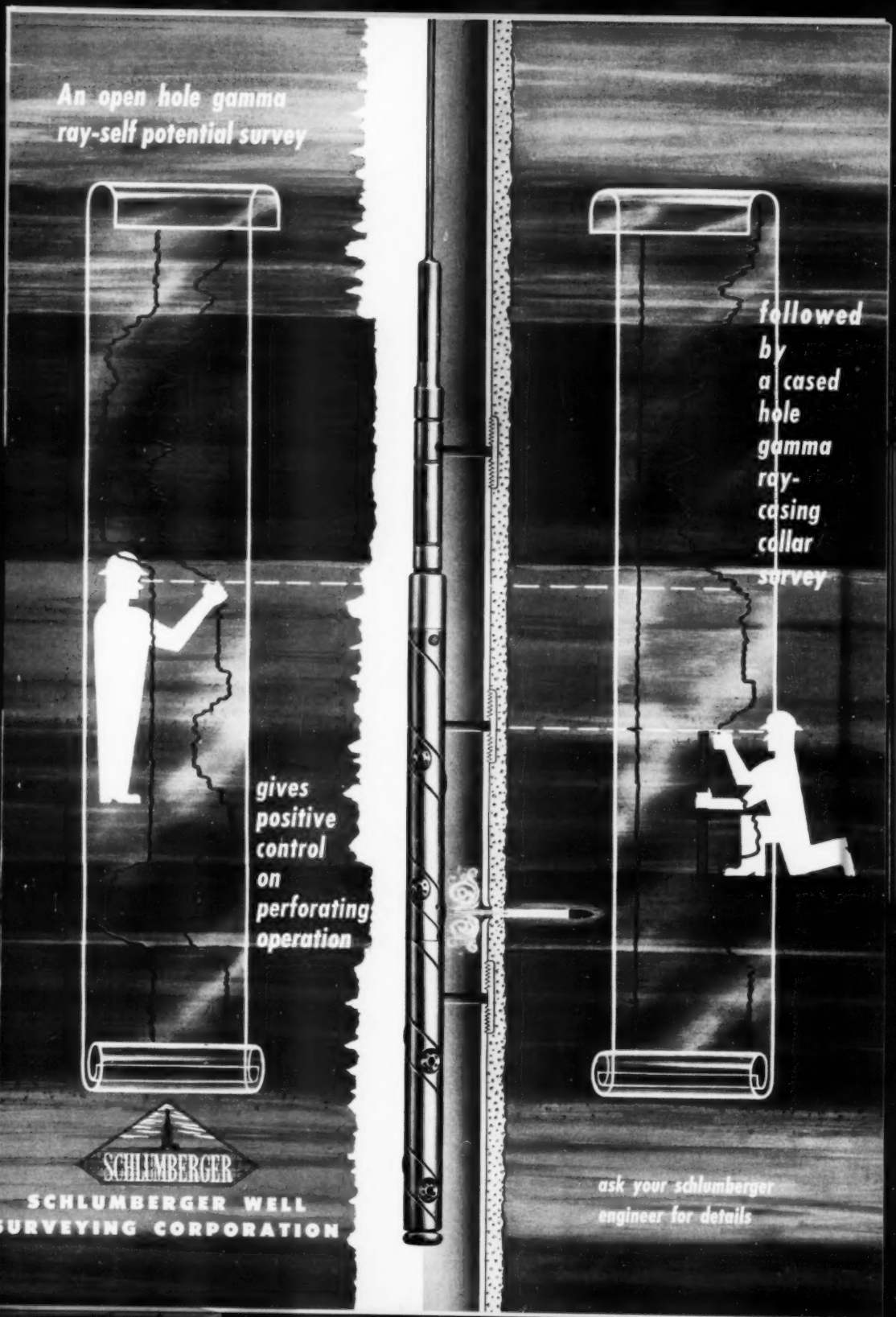
So much for history. Let us now consider the present economic stature of geophysical exploration. The Society of Exploration Geophysicists is professionally concerned with all geological exploration problems: petroleum, mining, civil engineering, and so on. The applications to exploration for petroleum are well developed. Last year, official S.E.G. records show, $325,000,000 was invested in world-wide geophysical explorations by the oil industry alone. This represents a phenomenal increase over 1950 of $100,000,000, an increase of nearly 50 per cent. Additional millions were undoubtedly spent in mining explorations and for research in the improvement of present techniques and the development of new methods. The increased expenditures last year are due partly to inflationary rise in costs and partly to increased activity. When we realize the magnitude of our present operations, we must concede that we are no longer in the geophysical game. We are in the geophysical business.

Activity high.—Geophysical explo-

*President, Society of Exploration Geophysicists. Presidential address to the joint annual convention of A.A.P.G., S.E.G., and S.E.P.M., Los Angeles, March 24-27, 1952.

†E. A. Eckhardt, "A Brief History of the Gravity Method of Prospecting for Oil," Geophysics, Vol. 5, July 1940.

‡E. DeGolyer, "The Development of the Art of Prospecting," Cyrus Fogg Bracket Lecture, Princeton University, 1940.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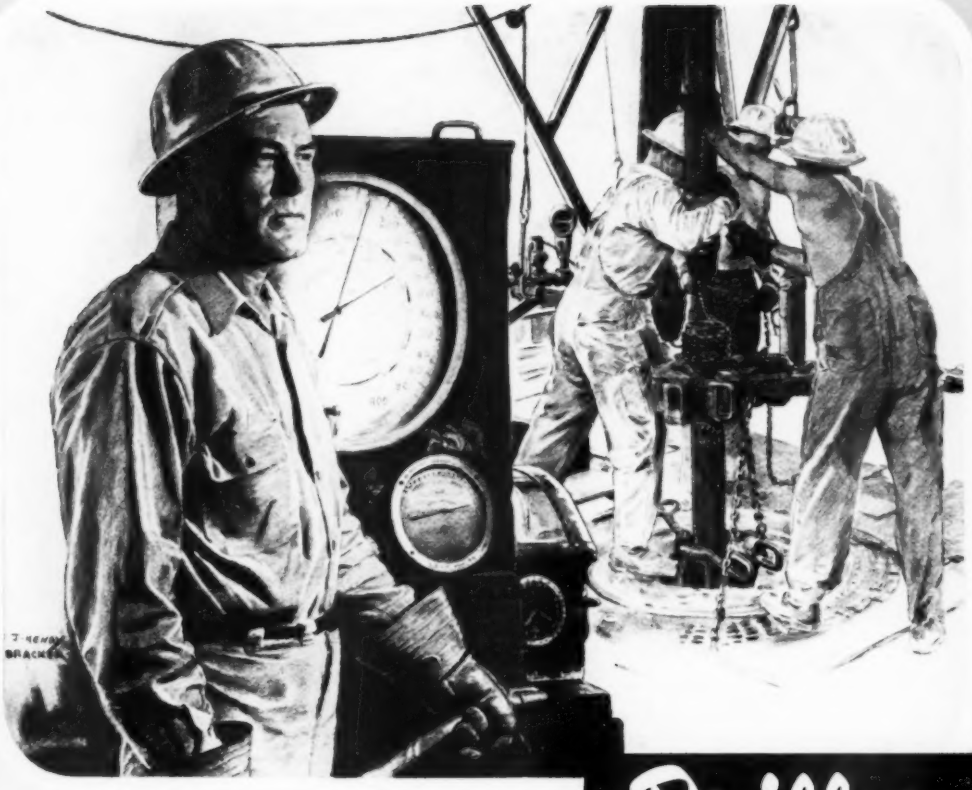
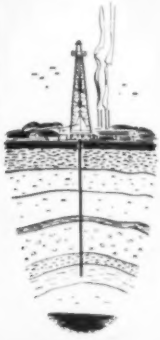


The Drilling Contractor's Driller

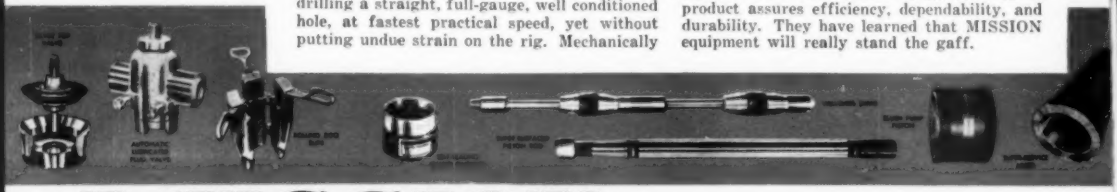


In the past ten years, the average speed of making hole has been increased about 35% — a remarkable achievement! Improved equipment has had much to do with this... but much of the credit must also go to the man who *operates* the equipment.

Drillers have been called the proudest men in the industry. They accept the complex responsibilities of actually drilling the wells. In the last analysis, it is the skill of the Driller that determines the cost per foot of hole. He is assisted by his crew of four, but he is in direct charge of operating the rig throughout his 8-hour tour, and he personally manipulates the principal mechanical controls.

Carrying out general directions from the Tool Pusher, the Driller is responsible for drilling a straight, full-gauge, well conditioned hole, at fastest practical speed, yet without putting undue strain on the rig. Mechanically minded to start with, the Driller has come to possess a sixth sense which enables him to judge by the behavior of the drill stem and the feel of the brake lever, just what is happening a mile or two miles down, at the bottom of the hole. He is responsible for maintaining correct speed of rotation, weight on the bit, pump pressure, and makes such important decisions as when bit should be changed, etc. The efficiency of the rig and crew are his responsibility.

With his fingers on the pulse of his rig 8 hours a day, no one has a greater appreciation of fine equipment than does the Driller. It is therefore significant that the Drillers of the nation and of the world have only highest praise for MISSION equipment. Through 25 years of actual experience, Drillers have learned that the name "MISSION" on a product assures efficiency, dependability, and durability. They have learned that MISSION equipment will really stand the gaff.



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ration activity today,* on a world-wide scale, marks an all-time high: 791 seismic crews, an increase of more than 20 per cent over 1950; 123 gravity crews, an increase of 12 per cent over 1950. Surprisingly, the trend of geophysical activity last year was toward the United States, away from foreign areas. This probably reflects industrial concern over unstable political philosophies about mineral resources.

Value of Geophysics

The mineral industries, the petroleum industry in particular, are investing great sums of money in geophysical exploration. The commercial acceptance of geophysics is justified by its success. Lahee's well-known and exceedingly useful statistical analyses† report the success expectancy of a wildcat well drilled in the hope of discovering a new oil field (a "new-field wildcat" in Dr. Lahee's terminology) for various bases of selecting the drilling site. Rounding out the small annual fluctuations (which are not significant for our purpose), we get averages for the last 5 years (1947-1951) in the United States as follows:

Basis—	Success ratio
Nontechnical (random drilling)	1 in 30
Geological	1 in 10
Geophysical	1 in 6
Combined geological and geophysical	1 in 5

Dry-hole savings.—The improvement resulting from the application of the best modern exploration technique—geology and geophysics combined—is very impressive. Compared to random drilling, the saving amounts to 25 dry holes per discovery, 4 dry holes instead of a wasteful 29. When we consider that the total expenditure for the geophysical data is only about 10 per cent of the total cost of oil exploration, these statistics take on additional significance.

And still, Dr. Lahee's tables continue to show, year after year, a surprisingly large number of wildcats in the nontechnical column! It is encouraging to see, however, that the number is gradually decreasing. Here, indeed, is a fertile field for our public-relations committees.

Technical Achievements

Modern geophysical instruments and techniques are well developed, especially in the United States and Canada. Qualified geophysicists throughout the would concede freely that American instruments and American geophysicists are the best to be had. The technical achievements are indeed impressive.

Let us consider one example. Twenty odd years ago, the establishment of a single gravity station required 2 full days with a large truck load of equipment, and the result which did not become available until the pendulum could be standardized at the home base several months later had a probable error of plus or minus 2 or 3 milligals. Today, only two short decades later, a modern gravimeter about the size of a 2-qt. Mason jar and weighing only 6 lb. will establish a gravity station in about 2 minutes with an accuracy of plus or minus 0.03 milligal. This represents a fiftyfold advantage in weight, a hundredfold gain in accuracy, and a five-hundredfold gain in speed. Similar examples could be cited with other geophysical instruments. Without these technological improvements, geophysical prospecting as we know it today would be entirely ineffectual and prohibitively expensive.

Trained geophysicists.—An asset of even greater importance is our stock of trained geophysical manpower which has been painstakingly assembled and carefully nurtured over the years. The solution of complex geological exploration problems, even with the best geological and geophysical data obtainable, depends essentially, in the final analysis, upon the interpreter's personal experience and judgment. The present and prospective shortage of technical talent in our schools and colleges presents a challenge which we must meet.

Problem of the Future

Let us now peer into the future. We are often reminded that our present proved petroleum reserves are only sufficient to supply the wheels of industry for about 15 years and, therefore, that we have an urgent need, in the face of rising demand, to increase the discovery effectiveness of our exploration techniques. That is a real problem which faces us right now—today. Many geophysicists, and geologists, are devoting their best efforts, generously supported by management, toward the solution of this problem. I am quite confident that so long as any oil remains in the earth to be discovered, profitably, it will be found.

We are not doing too badly right now. Last year, according to published statistics, the United States produced 2,243,000,000 bbl. of crude oil. That is a lot of oil—an all-time record. It takes a lot of doing to discover enough new oil to supply such a demand. However, the exploration departments of the American oil industry did even better. The estimated amount of reserves in the new oil discoveries during 1951 not only replaced the amount consumed but also added about 1½ billion barrels to the "proven reserves."*

On the other hand, young men entering college are often deterred from choosing geophysics or petroleum geology as a career because they have heard the prophets of doom shouting about the impending shortage of oil. Unfortunately, it is the brightest young men, the men who could be expected to contribute most to the solution of the problem, who give heed to these dire predictions and are misled into other fields of endeavor.

End not in sight.—Therefore, it is worth while to take a broader view. The total amount of petroleum discovered throughout the world to date, including about 70 billion barrels consumed and 80 to 100 billion barrels in the "proven reserves," is about 150 billion barrels. Estimates of potential world petroleum resources which remain to be discovered are about 600 billion barrels† or four times as great. At the present world-wide discovery rate of about 6 billion barrels of oil per year, this should keep us in the business for about 100 years.

Even this bright picture might be unduly pessimistic. It is based on the tacit assumption that oil is a one-crop proposition and that none is being formed in the earth today to provide distant future discoveries. Recent evidence suggests the attractive possibility that oil may, in fact, be forming in the vast volume of sediments being deposited today.‡ This opens possible glorious vistas for the future.

As a professional society, the commodities the Society of Exploration Geophysicists has to offer the exploration industry are instruments, techniques, and ideas. Of the three, ideas are by far the most important. Paradoxically, ideas, while rare, are the cheapest ingredient of our industrial economy. The success or failure of a wildcat well costing perhaps at much as a million dollars is often crucially dependent upon the mental inspiration of the exploration geophysicists and geologists who selected the drilling site. It is the recognized responsibility of our societies and of meetings such as this to inspire all of us to new and better ideas to improve our exploration techniques now and in the years ahead.

Solution Lies in Ideas

The president of a large oil company said recently:* "Science and technology are the biggest forces for progress in the oil industry today. Almost all of our present techniques and operating procedures are the results of improvements and developments made by scientists, engineers, and technologists. The conclusions of the technical men serve as a base for the decisions of management."

*E. A. Eckhardt, "Geophysical Activity in 1951," official committee report to Society of Exploration Geophysicists, Los Angeles, March 24, 1952.

†F. H. Lahee, "Exploratory Drilling in 1950," A.A.P.G. Bulletin, Vol. 35, June 1951.

*Philip C. Ingalls, "Total Reserves Near 32 Billion Barrels," The Oil and Gas Journal, January 28, 1952.

*L. F. McCollum, "Petroleum Industry Benefits from the Application of Science and Technology," The Mines Magazine, Vol. 39, December 1949.

†Gail F. Moulton, "Is American Petroleum the Cause or Result of the Greatest Prosperity Known in History," Petroleum Engineer, Vol. 22, October 1950.

‡Paul V. Smith, Jr., "Preliminary Note on Origin of Petroleum," Bulletin A.A.P.G., Vol. 36, February 1952.

THE QUANTITATIVE INTERPRETATION OF RADIOACTIVITY LOGS

by R. E. Fearon* and E. S. Mardock*

Here is another technical paper from the distinguished meeting of the Third World Petroleum Congress held at The Hague, which the Journal publishes via exclusive arrangements with the congress and the author.

THE accuracy of radioactivity logs has been improved to the degree that it is now possible to consider the quantitative application of these curves to the problems of reservoir engineering. The use of the neutron curve in estimating the porosity of a given productive zone is now common practice in some areas. This has been described in the literature.[1,2,3]

1. Response of Radioactivity Logs

1. The Gamma-Ray Curve

The most useful application of radioactivity logging (and also original) is its use in stratigraphic correlation work. For this purpose the gamma-ray curve which determines the relative gamma-ray intensities emitted by the strata, is very well suited because it is affected less by bore-hole conditions, i.e., casing and hole size, than any other logging curve available. Also, the concentration of radioactive contaminant in sands, limestones, dolomites, and shales is sufficiently consistent over wide areas that it is possible to identify shales by their relatively greater activity, and thus differentiate between shales and the clean pay strata when the latter are interbedded with shale.

The response of the natural gamma-ray curve can be explained on the apparently simple basis that some types of rocks radiate more gamma rays than others, and Russell[4] has shown that there is a strong correlation between a rock classification type and the intensity of the gamma radiation emitted by the members of the class type. Thus, marine shales and volcanic-ash materials are indicated by the gamma-ray curve by high gamma-ray intensities while clean sands, dolomites, and limestones are indicated by low intensities.

2. The Neutron Curve

The neutron curve assists in solving correlation problems because it is affected more strongly by lithological conditions and factors such as the hydrogen content (liquid-filled porosity). The combined use of both the gamma-ray curve with the neutron curve results in a well log very helpful in distinguishing and locating shale, fluid-filled porosity, dense nonporous rock, anhydrite, granite, and potash beds. These uses have been described previously in the literature.[2,3,4,5,6]

The neutron curve responds to varied lithologic conditions in such a manner that the curve always moves to the left to indicate a decrease in radiation as the detecting instrument passes from a stratum of dense rock (limestone) into a stratum of porous rock or shale. This behavior is chiefly due to the occurrence within the porous or shaly zone of a greater quantity of hydrogen atoms for a given volume of rock than occurs within the dense zone.

Porosity.—It has been shown[7,8] that in those sections wherein the rock is of fairly constant chemical composition, e.g., as in the majority of limestones and dolomites, it is possible to use the neutron curve in a quantitative manner to estimate the porosity of the rock when the latter are filled with liquid hydrocarbons or water. The empirical relationship shown in Fig. 1a has been found to exist in those cases. Fig. 1b shows the same relationship plotted on semi-log paper as a matter of convenience.

The method of practical application is based on the assumption that this relationship between the porosity, and the neutron curve deflections applies to any formation for which the chemical composition remains constant, and therefore the scattering observed in the data is due to (1) errors in measurement (which are discussed later on in this paper), and (2) errors in sampling arising from the fact that the formations are not homogeneous as to porosity, and that the particular region sampled by the neutron curve may differ from that sampled by the coring process.

3. Measurement of Neutron-Curve Deflections

In practice, the neutron-curve deflections are measured from a reference line parallel to the axis of the ordinates, and plotted as the abscissa (linear scale) while the porosity values are plotted as the ordinates (log scale) on a sheet of semi-log graph paper. A straight line is then drawn through the scattergram thus formed, in an estimated best fit to plotted points. This line is then used as the calibration chart for estimating neutron derived porosities from the given neutron curve.

The plotting and estimating procedure is most simple and orderly if deflections of the neutron curve are treated as units of radioactivity rather than as distances of pen travel. This technique is effectuated by plotting the same unit of radioactivity as is used in determining the sensitivity of the curve. The curve sensitivity is

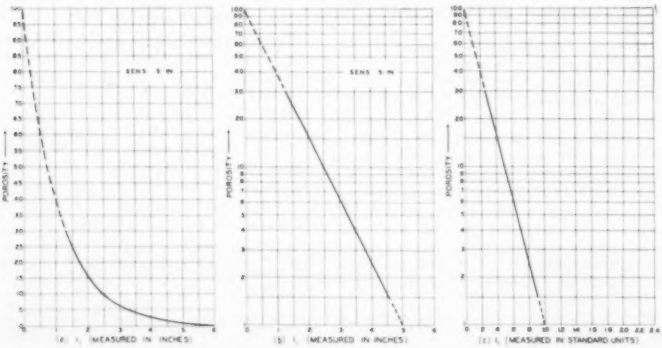

Fig. 1—Relationship of neutron curve deflection (I_1) to neutron derived porosity.

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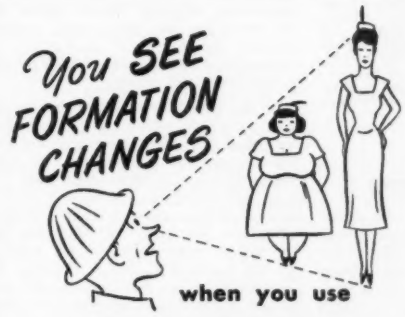

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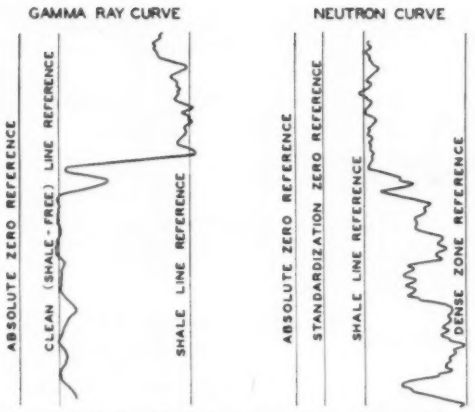

Fig. 2—Relationship between relative reference lines and instrumental reference line.

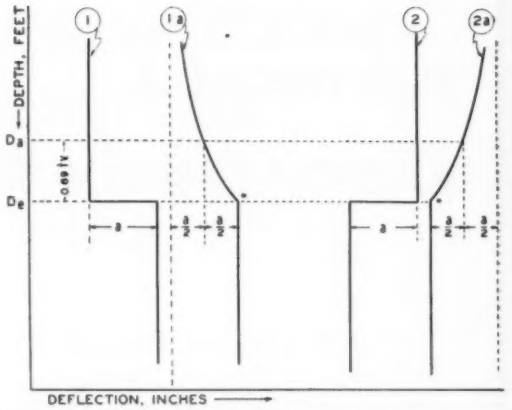

Fig. 3—The above pairs of idealized curves represent, in each case, a comparison between an exact curve of the variation of the properties of the strata (curves 1 and 2) and a corresponding representation of the kind that would be produced by a well-logging apparatus with an exponential response.

the deflection measured in inches which is produced when a standard radium source is placed at a standard position with respect to the detector. If, for example, in a gamma-ray log the instruments are adjusted to log on a sensitivity scale of 4 in., a log will result in which whole deflections are twice as great in amplitude as those of a log produced when a sensitivity scale of 2 in. was used.

Not only does the procedure of treating deflections as fractions of a radioactivity unit simplify interpretations within a given log, but this technique also facilitates comparisons of deflections in different logs. The "standard unit" concept is applied to a neutron log by dividing the neutron-curve reflections by the sensitivity of the curve and constructing a calibration chart from these units. The data of the calibration chart shown in Fig. 1b are shown replotted in Fig. 1c in terms of "standard units."[6]

4. Reference Lines

The neutron-curve deflection may be determined in any one of several ways, depending on the type of logging data available. Relative reference-line methods, i.e., methods wherein shale and dense zone lines are determined from the log,[7] have the advantage that they may be used with old logs for which instrumental reference lines may not be available. Instrument "zero" reference lines are, however, available for new logs at the present time, and both kinds of these reference lines are therefore available, depending upon the type of logging equipment serving the producing area in which the well is situated.

The first instrumental reference line used was the "standardization zero reference"[8] so called because it is determined at the time the sensitivity of the instrument is being determined, and it is the position of the recorder pen when only the background radiation at the surface is affecting the detector, i.e., the position of the recorder pen when neither the standardization source nor the neutron source are located in sufficiently close proximity to the detector that they produce a noticeable effect upon it. The disadvantages of this reference lie in that it will vary from place to place because of varying background conditions, and furthermore that it cannot be determined in the well and is therefore subject to error due to drift.

The second instrumental reference is the position of the recorder pen at absolute zero radioactivity.[5] The absolute zero radioactivity reference line is the only reference which will remain constant from well to well and from one locality to another, and therefore it is the preferred "zero" datum for reference. A chart which compares the different zero choices is shown in Fig. 2.

2. Accuracy of Radioactivity Logging

The reader who has inspected radioactivity logs has become aware of the presence of two kinds of character in the log deflections. These are meaningful deflections which convey valuable information through correlation with the lithologic types present and there are the meaningless deflections sometimes referred to as statistical fluctuations.

1. Need for Quantitative Understanding of Limits of Accuracy

In the use of radioactivity well logs for quantitative purposes, it is important to know to what limits their accuracy can be relied on. This knowledge is required for a number of purposes.

Often it is desired to compare depths of corresponding strata in several wells. Inevitably there may be error due to failure to correctly choose the corresponding points upon which to base such comparison. Also, it is evident that there will be an error because of the randomness which exists in the measuring processes, if fine limits of accuracy are to be considered.

Moreover, there is often an interest in the accuracy with which some parameter related to the deflection may be ascertained. For example, in the case in which we attempted to calculate the porosity of a limestone from the neutron curve, there will be error in the calculated porosity caused by whatever inaccuracy attended the determination of the neutron-curve deflection.

If the question of whether the producing value of an oil-bearing zone justifies the cost of completion is a close one, the application of error study to all the significant data, i.e., logs, core analysis, data, etc., is necessary or the operator cannot properly know the odds for winning. Because of such reasons and because of the increasing use of neutron and gamma-ray logs for quantitative purposes some consideration is given hereinafter to principal types of errors, and how they may be treated.

In a brief study of this kind, it is quite impossible to do justice to the entire subject of error in radioactivity logs. Rather than to make the treatment too superficial, the writers decided to select a few aspects of the subject which have immediate practical consequences, and center attention on these. We have further arbitrarily limited our scope to those parts of the subject which are not intermingled with geological, lithological, or geophysical considerations. We will concentrate rather on such systematic errors and such random errors as are chiefly related to characteristics of the logging equipment or process. These latter lend themselves very well to exact study, since

their causes are readily accessible for experiment.

2. Systematic Errors of Thickness and Depth

There is, associated with a well-logging system responding exponentially with respect to time, a corresponding depth constant. If the time constant is t seconds for the well-logging system to respond to a radiation intensity change, and the well is logged at the rate of v feet per second, the depth constant is tv. The significance of the depth constant is shown in Fig. 3.

There is, as can be seen, an error in depth in measuring any interface "top" between rock strata much thicker than tv feet, which error amounts to 0.69 tv feet. The "top" is 0.69 tv feet deeper than represented. This is the error which will exist if the "top" is picked at the half-value point on the transition as shown on the actual curve. If the corners (indicated by stars) can be picked, this error is eliminated. Statistical error, which is ignored in the figure, makes the corners difficult to pick, however. Quite often therefore, a "top" picked by the half-value point may be desirable.

Thickness of a stratum, the limits of which are judged by the method of picking "tops" from half-value, is represented by:

$$X = X' - tv \ln (e^{-X/tv} + 1)$$

where:

X' = apparent thickness, half-value basis
t = exponential time constant of well-logging system, sec.
v = speed of logging, ft./sec.
X = actual thickness of strata

When X becomes large compared with the depth constant tv, the quantity $tv \ln (e^{-X/tv} + 1)$ approaches zero as a limit and X' approaches X. Accordingly, it is a conclusion that, for layers much thicker than the depth constant, the half-value points give the correct thickness. The midpoint depth of the stratum is 0.69 tv deeper than the average of the two depths represented by the logging curve.

When X is much less than the depth constant, tv, the (half-value basis) thickness approximates $\frac{1}{2}$ X + 0.69 tv. The midpoint of the stratum is, for this case, $\frac{1}{4}$ X + 0.34 tv deeper than represented.

Thus, a thick stratum at a given depth will appear shallower than will a thin stratum having its median plane at the same depth. This error may be as great as 0.34 tv, but cannot be greater.

Intermediate cases correspond with values of X/tv between $\frac{1}{4}$ and 2. Table 1 gives values of corrections to be applied to upper limits of strata, lower limits, and middle planes, as determined by half-value method of picking "tops" for several values of X/tv between $\frac{1}{4}$ and 2.

The thickness of a negligibly thick layer causing a maximum or a minimum will always be represented as 0.69 tv feet. The above calculations apply to the case where tv exceeds substantially the length of the sensitive portion of the detecting instrument.

When the detecting instrument is very long compared with the depth constant tv, and of uniform sensitivity:

1. The thicknesses of thick layers is correct, with tops picked on the half-value basis.

2. Depth of both upper and lower boundaries is measured with an error small compared with the detector's sensitive length.

3. Maximum or minimum producing strata thinner than the detector length appear to be as thick as the detector's length.

TABLE 1—ERRORS OF DETERMINATION OF A UNIFORM STRATUM (HALF-VALUE BASIS) CAUSED BY EXPONENTIAL RESPONSE OF LOGGING SYSTEM

Unit of length used in table is tv feet; (t = time constant of exponential response in seconds, v = speed of logging in feet per second)

Thickness of stratum	Error of bottom*	Error of top*	Error of median plane*	Factor by which peak deflection must be multiplied to get correct value
0.25	0.117	0.693	0.405	4.52
0.50	0.219	0.693	0.456	2.54
0.75	0.306	0.693	0.500	1.89
1.00	0.380	0.693	0.537	1.58
1.25	0.441	0.693	0.567	1.40
1.50	0.492	0.693	0.593	1.25
1.75	0.533	0.693	0.613	1.21
2.00	0.566	0.693	0.630	1.18

*Actual log measurements are too shallow.

3. Random Errors of Thickness and Depth

The random error of a well-logging process can be rigorously studied by successively measuring a desired section of a bore hole and comparing the measurements. A suitable method of comparison consists in the point-by-point subtraction of the abscissas of the two curves for depths taken at a sequence of equal depth intervals.

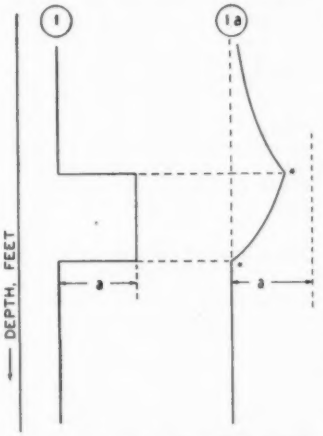

Fig. 4—This pair of curves represents comparison of an ideal measurement on a uniform stratum with sharp boundaries, and the actual curve produced by a system having exponential response.

In the above case, if half value picks are relied on, the lower boundary of the stratum would be chosen only a little below its actual center, and the upper boundary would be considerably above the actual upper boundary of the layer. Also, the right-hand curve falls considerably short of the asymptote represented by the dotted line. These errors may be corrected by running the log slower or by speeding up the time constant.

The interval between depth points at which the abscissas are subtracted preferably should be greater than the depth constant tv. In order to produce a distribution curve from the subtracted data it is necessary to remove all systematic variations. (The procedure for doing this is illustrated in the appendix to the paper offered by the authors at The Hague Conference, 1951.)

Having prepared data from which all constants and systematic variations have been removed, a frequency distribution is plotted on arithmetic probability coordinates. The straightness of the line obtained on these coordinates is a test of whether or not the deviations correspond with the normal error law. Almost always it will be found that they do not. The deviation from normal error is usually most notable for the infrequent data corresponding with relatively large deviations.

The occasional occurrence of errors which are random in direction but which are found more often than they should be in a common characteristic of most measuring equipment, including that used for radioactivity logging. Nonetheless, if the deviations from normal error are very large there is some justice in thinking that the measurements are poor.

Several normal probability tests are shown in Fig. 5. It will be seen that in two of the illustrated cases the system of data which was taken showed a frequency of occurrence of the large deviations which is greater than would be expected from a normal error curve fitted to the distribution of the more plentiful data.

4. For Determining Error for a Log Without a Check Run

A procedure is available which gives plausible results in the determination of the error due to chance variations within an isolated section of log. This procedure begins by retracing the log beside itself but displaced horizontally by a convenient amount, and displaced vertically by an amount corresponding with an interval of depth preferably not greater than the length of the sample.

Having such a parallel arrangement of curves, the next step in the procedure is to subtract abscissas just as though the displaced log were be-

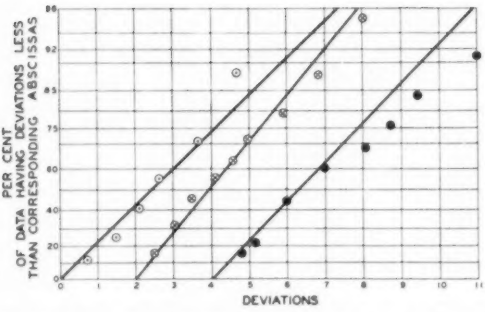

Fig. 5—The three plots represent in each case the abundance of data corresponding with deviations less than any given number of millimeters.

The coordinates are arithmetic probability (vertically) versus a linear horizontal scale. If the distributions satisfied the normal error law, all the above points would lie on straight lines. Left-hand curve (circles with dots) is a frequency plot of the deviations of the difference of deflections obtained at the same depths in the same well. Middle curve (circles with X's) is a frequency plot of deviations obtained during a period of time during which the instrument hung stationary in the well. Right-hand curve (solid black circles) is a frequency distribution of the difference between a given log and itself, displaced 2 ft. in depth.

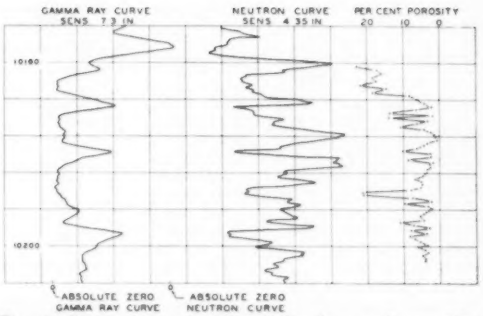

Fig. 6—Comparison of radioactivity logs and porosities (Pennsylvanian section, Magnolia Petroleum Co. T. X. L. "A," No. 2, Pegasus field, Upton County, Texas.

ing used for a check run. When the average value of the table of subtracted numbers is taken from each term of that table, a new table results in which the figures are sometimes positive and sometimes negative. A frequency distribution of these positive and negative quantities may then be attempted.

The probable error which will be estimated for the log can be deduced from the line drawn to fit the plentiful part of the data (say from 5 to 80 per cent) on arithmetic probability coordinates. The less frequent large deviations will correspond with subtractions which occurred between points in the vicinity of an appreciable change of the actual characteristics of the strata. The data may be made manageable in this respect by purposely ignoring sections of the log which are not monotonous and reserving the monotonous portion for this study.

The probable error obtained from the above-described procedure is not the probable error of the log but must first be corrected in two ways:

1. The deviations that are obtained would be more than the probable error by a factor of the square root of two if the displaced curve were thought of as being an independent run.

2. Because the subtracted curves are not independent runs, and because of the electrical "memory" of the recording system, the deviations are made to appear less than they should be, and have to be multiplied by $1/(1-e^{-\Delta/tv})$, where Δ is the depth displacement of the two logs, t is the time constant of exponential response of the measuring system in seconds, and v is the speed of logging in feet per second.

These corrections are represented in the formula:

$$P_e = \frac{P_e'}{(2)^{1/2}\,(1-e^{-\Delta/tv})}$$

where P_e' is the distribution constant obtained as above described, and P_e is the statistical probable error of the log, for the values of abscissas in the vicinity of those which are typical of the monotonous zone used for the computation of P_e'.

(a) Comparison of error distributions obtained in various ways.

The error distribution obtained by subtracting two logs agrees as well as may be expected with the error distribution obtained by running the paper against a time axis, with the subsurface logging equipment stationary in the well. These distributions also agree rather better than may be expected with the probable error obtained by the procedure outlined in the previous paragraph. Very great reliance cannot be placed on this agreement, however, since the quantity tv was not very accurately known for this instrument. The comparison of the figures thus obtained is shown in Table 2.

TABLE 2—PROBABLE ERROR OF LOGGING CURVE

P_e calculated by difference of repeat logs	1.70
P_e from deviations with respect to time	1.85
P_e from deviations of displaced curve minus original curve	1.85

(b) Conditions appropriate for testing error of a log where there is no repeat run.

In view of the fact that very little experience has as yet been had with the new method of error testing (without using a check run), which is described in this paper, considerable precautions should be employed in choosing conditions and method of its application. Also, until more abundant experience has been compiled it is not desirable to attempt to use the results of this procedure for purposes where stringent quantitative requirements exist for determination of the probable error. Where there is a stringent need for accurate knowledge of probable error, it is still urged that subtraction of check runs be relied upon, since it is a more rigorous approach.

For the use of the less rigorous method of testing an isolated log, an interval of the log to be tested should be chosen which is as monotonous as possible. Very great care and accuracy are demanded in the retracing and displacement operation described above. If for any reason it is not convenient to conduct the careful retracing, an alternative procedure may be used. The alternative consists in tabulating from an arbitrary zero line parallel to the time axis, the abscissas corresponding with the monotonous portion of the curve and taking the tubular difference term by term.

It will be noted that the choosing of a monotonous portion is but one of the safeguards which have been provided against an incorrect distribution being obtained because of existence of significant deflections of the curve. The other safeguard is our insistence upon deriving the probability curve by a fit of the abundant data, ignoring completely the infrequent but larger deviations.

It is necessary that the portion of the curve to be so tested be chosen from enlarged scale preferably at least 5 in. per 100 ft. Also, it is essential that the curve selected for this study not corresponds with high logging speed. High logging speed would make the $1/(1-e^{-\Delta/tv})$ correction term large. If this correction term is large, the distribution parameters will be inconveniently small, making their accurate determination much more problematical. In a practical case, Δ may be 2 ft., the quantity tv may be 1 ft., and sampling length also approximately 2 ft.

In a practical case, it is necessary also to take care that there are enough data points. The example mentioned in this paper corresponded with somewhat over 60 such points. It is apparent that this quantity of data is really less than the optimum desirable amount corresponding with reasonable balancing of the effort expended

TABLE 3—CHANCE THAT SIGNIFICANT DATA OF DEFLECTION IS MORE OR LESS THAN:
(Unit = 1.414 P_e)

Deflection	—5	—4	—3	—2	—1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
0	.9996	.997	.978	.911	.75	.5	.25	.089	.022	.003	.0004	0	0	0	0	0	0	0	0	0
	.0004	.003	.022	.089	.25	.5	.75	.911	.978	.997	.9996	1	1	1	1	1	1	1	1	1
1	1	.9996	.997	.978	.911	.75	.5	.25	.089	.022	.003	.0004	0	0	0	0	0	0	0	0
	0	.0004	.003	.022	.089	.25	.5	.75	.911	.978	.997	.9996	1	1	1	1	1	1	1	1
2	1	1	.9996	.997	.978	.911	.75	.5	.25	.089	.022	.003	.0004	0	0	0	0	0	0	0
	0	0	.0004	.003	.022	.089	.25	.5	.75	.911	.978	.997	.9996	1	1	1	1	1	1	1
3	1	1	1	.9996	.997	.978	.911	.75	.5	.25	.089	.022	.003	.0004	0	0	0	0	0	0
	0	0	0	.0004	.003	.022	.089	.25	.5	.75	.911	.978	.997	.9996	1	1	1	1	1	1
4	1	1	1	1	.9996	.997	.978	.911	.75	.5	.25	.089	.022	.003	.0004	0	0	0	0	0
	0	0	0	0	.0004	.003	.022	.089	.25	.5	.75	.911	.978	.997	.9996	1	1	1	1	1
5	1	1	1	1	1	.9996	.997	.978	.911	.75	.5	.25	.089	.022	.003	.0004	0	0	0	0
	0	0	0	0	0	.0004	.003	.022	.089	.25	.5	.75	.911	.978	.997	.9996	1	1	1	1
6	1	1	1	1	1	1	.9996	.997	.978	.911	.75	.5	.25	.089	.022	.003	.0004	0	0	0
	0	0	0	0	0	0	.0004	.003	.022	.089	.25	.5	.75	.911	.978	.997	.9996	1	1	1
7	1	1	1	1	1	1	1	.9996	.997	.978	.911	.75	.5	.25	.089	.022	.003	.0004	0	0
	0	0	0	0	0	0	0	.0004	.003	.022	.089	.25	.5	.75	.911	978	.997	.9996	1	1
8	1	1	1	1	1	1	1	1	.9996	.997	.978	.911	.75	.5	.25	089	.022	.003	.0004	0
	0	0	0	0	0	0	0	0	.0004	.003	.022	.089	.25	.5	.75	.911	.978	.997	.9996	1
9	1	1	1	1	1	1	1	1	1	.9996	.997	.978	.911	.75	.5	.25	.089	.022	.003	.0004
	0	0	0	0	0	0	0	0	0	.0004	.003	.022	.089	.25	.5	.75	.911	.978	.997	.9996
10	1	1	1	1	1	1	1	1	1	1	.9996	.997	.978	.911	.75	.5	.25	.089	.022	.003
	0	0	0	0	0	0	0	0	0	0	.0004	.003	.022	.089	.25	.5	.75	.911	.978	.997

against the results obtained. It is the opinion of the writers that approximately 150 data points would be suitable number for further efforts to apply the new method of appraising error of logs where check runs are not available.

5. The Probability That a Given Deflection Is Significant

The question to which this discussion is directed is only interesting in two cases:

1. When the deflection is comparable with or only slightly greater than the probable error.

2. When the operator is critically interested in the accuracy of the significant portion of a deflection.

In considering the question of a significance of a deflection one must know the probable error of the system of measurements of which the particular deflection composes a part, and must relate this to the calculation of the chance that any assumed value of the deflection (greater or less than the measured value) will occur. Significant data, as the term is treated here, simply means those data which would result from the averaging of the corresponding abscissas of an indefinitely large number of precisely similar logging measurements in the same well. The question of significance as it is considered here has no bearing whatever on the supposed relationship or absence of relationship of the above-defined significant value to any other rock characteristics.

Since a deflection is always a difference of the measurements which exists before the deflection commenced and at the limit of its excursion, the probable error of its magnitude is greater than the probable error of the measurements corresponding with single abscissa by a factor of the square root of two. If the deflection is not an exceedingly larger one, the assumption that the probable error before it commenced and at the peak of its excursion is the same, is legitimate.

Also, it is not necessary that probable error which is used in reckoning the chance of significance of a deflection be determined for the exact portion of the log in which the deflection occurs. Probable error usable for the evaluation of chance that any given deflection is significant may be ascertained for any nearby monotonous portion of the log having an average value of abscissas corresponding roughly with that for the curve in the vicinity of the deflection.

Table 3 gives the evaluation of chance as it applies to deflections of various sizes compared to the probable error. It is convenient in this connection to use the square root of two multiplied by the probable error as a unit for the measurement of the deflection, and the table is prepared in that manner.

The probabilities in the table are expressed in the usual manner, on a scale in which one represents certainty and zero represents assurance that the event will not take place. It is evident that the sum of the probabilities that the significant data of a deflection will be more than, and that it will be less than, a given value must always be one.

To compute the probability that the significant data of a deflection will lie in a range, one may subtract the probability that it will be more than the upper limit of the range from the probability that it will exceed the lower limit of the range. In the table, "more than" and "less than" are used in the strict algebraic sense in which $2>1>0>-1>-2$, etc.

To apply the table to a negative deflection, one merely turns the log upside down, and labels abscissas backwards. It is to be noted, in connection with the table that probability over 0.9996 is stated arbitrarily as a certainty (value = 1) and probability less than 0.0004 has been arbitrarily assigned a zero value. A very satisfactory source of general information on the errors of measurement, applicable also to this work, is "Treatment of Experimental Data," by A. G. Worthing and J. Geffner (Wiley, 1946).

Examples of Quantitative Behavior

The radioactivity logs and porosity data from core analysis are compared here for two wells. These are for Magnolia Petroleum Co. T.X.L. 2 "A," Pegasus field, Upton County, Texas, and Imperial Oil Co., Ltd., 35 Egremont, Redwater field, Alberta, Canada. These examples were selected only to illustrate the application of radioactivity logging methods to different areas.

Cases of the application to other areas have been previously described elsewhere.[7,8,9] In this connection the writers believe that the engineers of Imperial Oil, Ltd., should be complimented upon their independent development of a similar method for the quantitative application of the neutron curve.

The T.X.L. 2 "A" log was run with an absolute instrument zero and the logs and core data are shown plotted together in Fig. 6. The neutron-derived porosity calibration curve is shown in Fig. 7. The inner heavy dotted lines plotted beside the

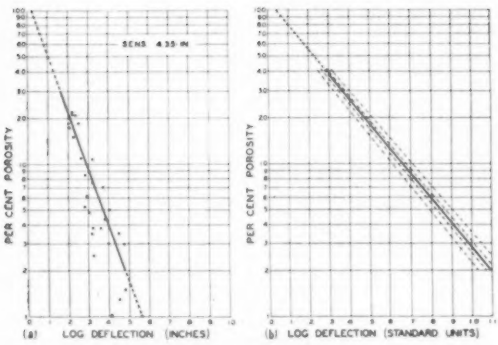

Fig. 7—Relationship of log deflection to neutron derived porosity (Magnolia's T. X. L. "A." No. 2).

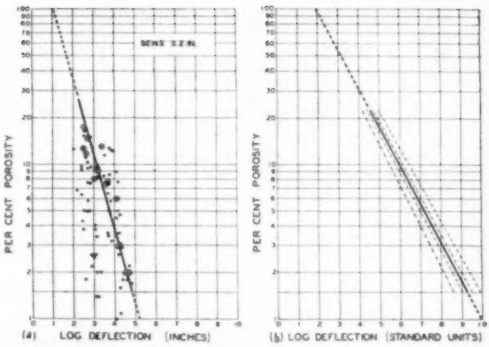

Fig. 9—Relationship of log deflection to neutron derived porosity (Imperial's 35 Egremont).

calibration chart (Fig. 7b) show the probable error as determined from Table 2, and extended by assuming that the error increases as the square root of the deflection.

The outer dotted lines indicate the probability limit of 4½ chances in 100 (computed from Table 3) that the deflection could not have been less than or greater than these limits. Other limits might be taken. Indeed, some arguments support the proposition that limits farther from certainty would be a more useful choice for "error" loci. The method of estimating these errors mathematically is developed in the latter part of the present paper.

It will be observed that the majority of the data for constructing the calibration chart of Fig. 7a fall within the probability limits of Fig. 7b.

The second example of the quantitative application of neutron logs is the 35 Egremont. The radioactivity curves and porosities are shown in Fig. 8 and Figs. 9a and 9b.

Equipment for determining an absolute zero was not available for logging this well and accordingly a "standardization" zero reference line was used.

The neutron-derived porosity calibration chart, Fig. 9a was constructed by drawing the straight line through the points corresponding with the thicker porous and dense zones, i.e., for points obtained in those intervals in which the neutron log trace was nearly vertical.

It will be noted that the data of Fig. 9a "scatter" rather badly and that a large number of points are outside the probability limits chosen. It is the opinion of the writers that a great deal of the scattering is due to the differences in sampling which occurred because the sample of the neutron curve is greatly different from that obtained by coring. The heterogeneity prevailing in the distribution of porosity in the rock is especially pronounced in limestone and dolomites.

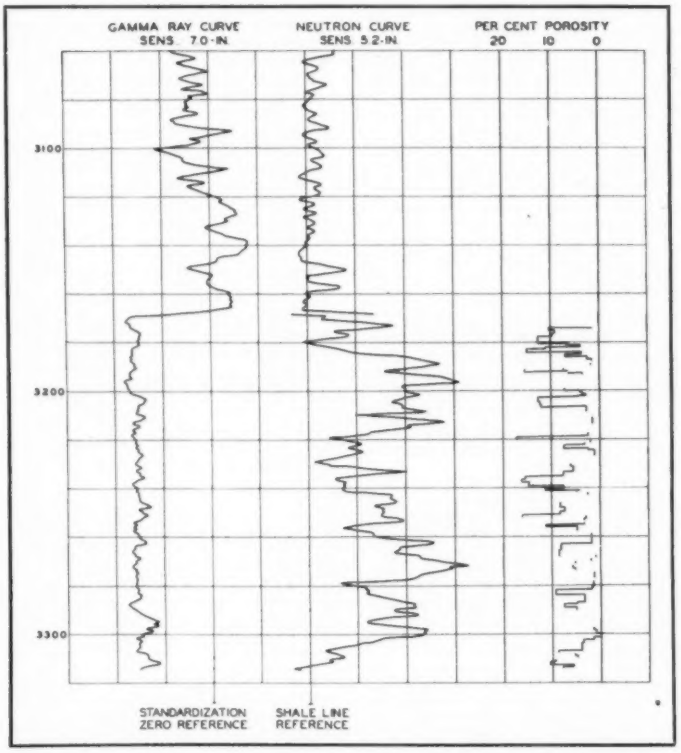

Fig. 8—Comparison of radioactivity logs and porosities (Imperial Oil, Ltd., 35 Egremont, Redwater field, Alberta, Canada).

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RESISTIVITY DEPARTURE CHARTS

by Hubert Guyod*

Resistivity departure curves can be presented in a variety of ways. By selecting the most appropriate presentation, the determination of true resistivity, hole diameter, and other factors is considerably simplified. This article offers new charts which will be found most helpful to those using resistivity data quantitatively.

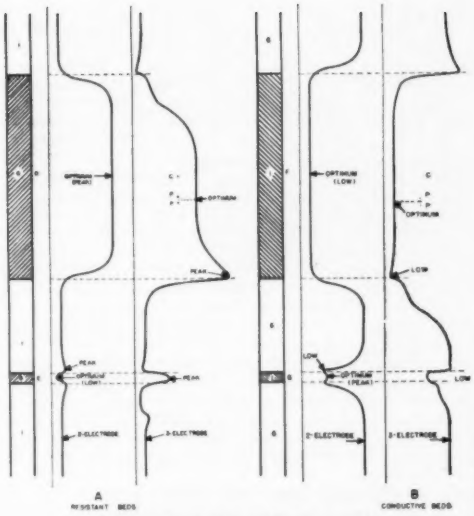


Fig. 1—Typical resistivity graphs.

THE apparent resistivity of a bed varies continuously with depth, even if the bed is uniform. When the resistivity data are used quantitatively, it is convenient to consider more particularly either the peak value, or the low value, or the optimum value.

Optimum Resistivity

Typical resistivity graphs are represented on Fig. 1. Resistant beds are on the left (Fig. 1A) and conductive beds on the right (Fig. 1B). The figures in the vertical columns indicate the resistivity of the beds concerned.

Two-electrode graphs.—Inasmuch as two-electrode graphs are symmetrical, it is logical to give particular attention to their apparent resistivity value at the center of the bed. This value is called the "optimum resistivity." The optimum resistivity equals the "peak value" for thick resistant beds only (bed D). For thin resistant beds (such as E) the optimum resistivity equals the "low" (i.e., minimum) value, and not the peak value. For thick conductive beds (F) the optimum value equals the low value, and for thin conductive beds (G) it equals the peak value.

Three-electrode graphs.—The concept of optimum resistivity is not so obvious for three-electrode graphs. By definition, the optimum value for a thick bed is the apparent resistivity measured when the current electrode C (or the pickup electrode if the reciprocal electrode arrangement is used) is at the center of the bed (see Fig. 1). It is less than the peak value for thick resistant beds, and higher than the low value for thick conductive beds. The concept of optimum resistivity breaks down when thin beds are considered, and only peak values (for resistant beds) or low values (for conductive beds) are used.

Optimum values (R_o), peak values (R_p), and low values (R_l) vary with the electrode spacing (S), bed resistivity (R_t), bed thickness (T), mud resistivity (R_m), and hole diameter (D). These variations are graphically represented by curves called "departure curves."

Unless specified otherwise the following assumptions will be made in this article:

1. The bed under survey is reasonably uniform.
2. The bed is very thick with respect to the maximum electrode spacing used (several times this spacing).
3. The formation in which the bed is situated has approximately the same resistivity as the mud.
4. The electrodes are small spheres centered on the bore axis. Although this condition is never fulfilled in practice, the resulting error is usually negligible for electrode spacings greater than about twice the bore diameter, and for electrode diameters less than one-third the bore diameter.

Resistivity of a Noninvaded Bed

Figs. 2 and 3 are conventional departure resistivity charts for thick beds which are not invaded by the drilling mud. Fig. 2 is for two-electrode arrangements, and Fig. 3 is for three-electrode arrangements. These charts were established by calculations.[1] They give curves representing the quantity R_t/R_m (ratio of optimum resistivity to mud resistivity), i.e., the resistivity departure, as a function of S/D (ratio of electrode spacing to hole diameter) for various values of R_t/R_m (ratio of true bed resistivity to mud resistivity). These departure charts permit determining the true resistivity of a thick uniform bed when a number of data are available.

To understand better how to obtain resistivity data from one of these charts it should be remembered that a departure chart expresses a relation between the five following quantities:

True bed resistivity,
Optimum resistivity,
Mud resistivity,
Hole diameter,
Electrode spacing.

Any one of these quantities can be determined from a departure chart when the four other quantities are known.

Inasmuch as the electrode spacings used in electrical logging are always known accurately, there remains only four variable quantities. It is obvious from elementary algebra that, if any one of these four quantities has to be determined, it is usually necessary to secure four independent relations between them. These relations can be either charts or physical measurements.

Generally, it is desired to determine the resistivity of a bed. To solve this problem, only one analytical relation is available: the departure chart corresponding to the electrode arrangement used. No other analytical relation can be established between the quantities involved: it is therefore necessary to make three appropriate physical measurements to obtain the desired information, for example the measurement of:

Mud resistivity (at temperature of bed concerned).

Hole diameter.

Optimum bed resistivity with an appropriate spacing.

It should be noted, however, that it is not necessary to secure mud re-

*Consultant, Houston, Tex.

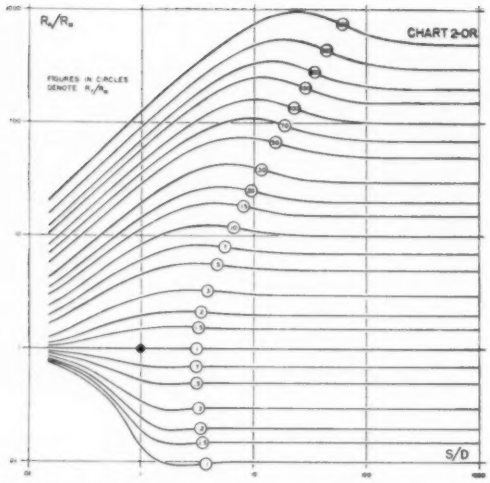


Fig. 2—Optimum resistivity departure chart for thick beds not invaded by mud and for two-electrode arrangements. (Adapted from data by Alpin.)

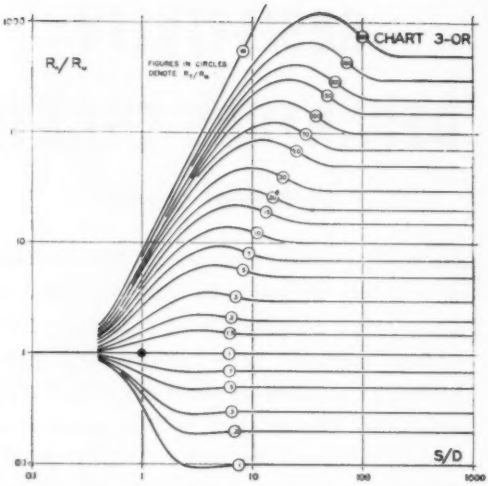


Fig. 3—Optimum resistivity departure chart for thick beds not invaded by mud and for three-electrode arrangements. (Adapted from data by Alpin.)

sistivity and/or hole-diameter data to solve the problem concerned. One or both of these quantities can be replaced by one or two additional resistivity measurements, respectively, made with appropriate electrode spacings. This is so because an optimum resistivity value expresses a numerical relation between the quantities involved in the problem.

Hence, a departure chart permits determining the resistivity of a thick uniform bed when either one of the following sets of measurements is available:

1. Mud resistivity.
   Hole diameter.
   Optimum resistivity obtained for one spacing.
2. Mud resistivity.
   Optimum resistivity for two different spacings.
3. Hole diameter.
   Optimum resistivity for two different spacings.
4. Optimum resistivity for three different spacings.

Use of one resistivity measurement. If resistivity measurements made with only one electrode spacing are available, it is first necessary to measure or determine as accurately as possible the mud resistivity and the hole diameter in the formation concerned. Then the quantities R_s/R_m and S/D are computed. The two numbers thus obtained are the coordinates of a point of the departure chart, and the departure curve passing through this point gives the resistivity contrast R_t/R_m, from which the bed resistivity R_t is determined.

Use of two resistivity measurements. If two resistivity graphs made with different electrode spacings (but pref-

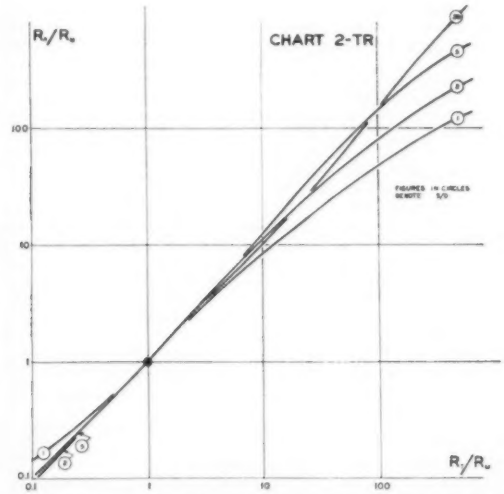


Fig. 4—True resistivity departure chart for thick beds not invaded by mud and for two-electrode arrangements.

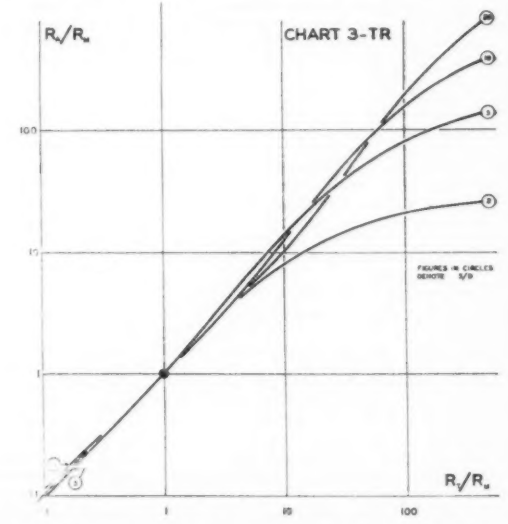


Fig. 5—True resistivity departure chart for thick beds not invaded by mud and for three-electrode arrangements.

erably with the same type of electrode arrangement) are available, either the mud resistivity or the hole diameter may be omitted. Suppose that the latter was determined accurately, but that no reliable value of the former is available. Let R_s and R'_s be the optimum resistivities for spacings S and S', respectively. The points of coordinates (R_s, S/D) and (R'_s, S'/D) are plotted on a transparent paper on which the log-log grid of the departure chart is traced. The ordinate axis of the transparent grid is made to coincide with that of the departure chart. Then the transparent paper is moved parallel to these axes until the two points fall simultaneously on the same departure curve. The ordinates R_s/R_m and R'_s/R_m of the two points, as well as the resistivity contrast R_t/R_m of the matched curve, are read off the departure chart. From these quantities, R_m and R_t are determined.

If the hole diameter is unknown but the mud resistivity is accurately determined, a similar procedure is used to determine R_t. In this case, the abscissa axes of the grids are superimposed and the transparent paper is moved parallel to these axes until the points of coordinates (R_s/R_m, S) and (R'_s/R_m, S') fall simultaneously on the same departure curve. The hole diameter and the formation resistivity are then determined as explained in the previous example.

Use of three resistivity measurements.—If there are no reliable data on the mud resistivity nor on the hole diameter, then the bed resistivity can be determined only if resistivity measurements R_s, R'_s and R''_s made with three different and appropriate spacings S, S' and S'' are available. The electrode arrangements used for this purpose must preferably be of the same type, otherwise the problem can be solved only by using a composite chart, which is not practical.

The true bed resistivity is determined by plotting the three points (R_s, S), (R'_s, S') and (R''_s, S'') on a transparent log-log grid, superimposing it on the departure chart, and moving it parallel to the two coordinate axes until the three points fall simultaneously on the same departure curve. From the resistivity contrast of the matched curve and from the point coordinates read off the chart, it is possible to determine R_t as well as the mud resistivity and the hole diameter.

The curve-matching procedure outlined above is made easy if the transparent grid is fastened to a drafting machine.

Sometimes it happens that there are more resistivity data than theoretically needed. All these data should be used for the matching procedure in

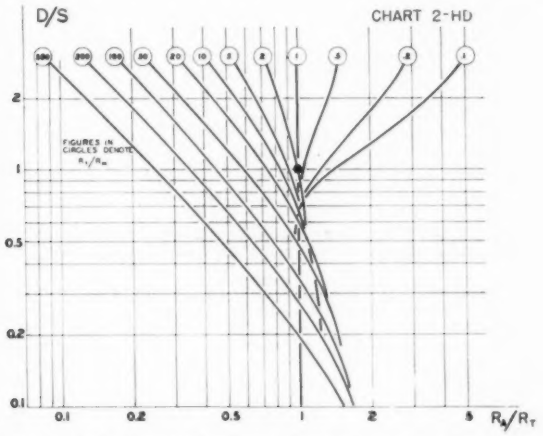


Fig. 6—Hole-diameter departure chart for beds not invaded by mud and for two-electrode arrangements.

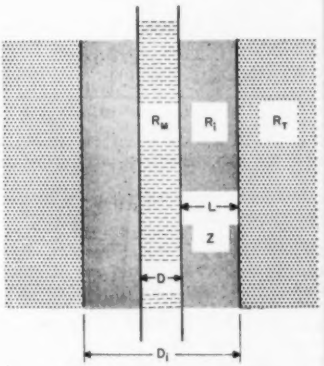


Fig. 8—The three media.

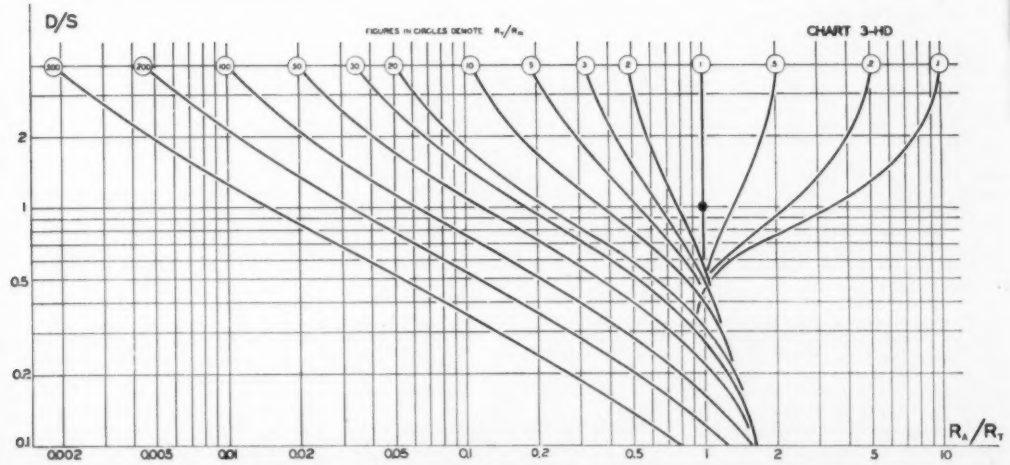


Fig. 7—Hole-diameter departure chart for beds not invaded by mud and for three-electrode arrangements.

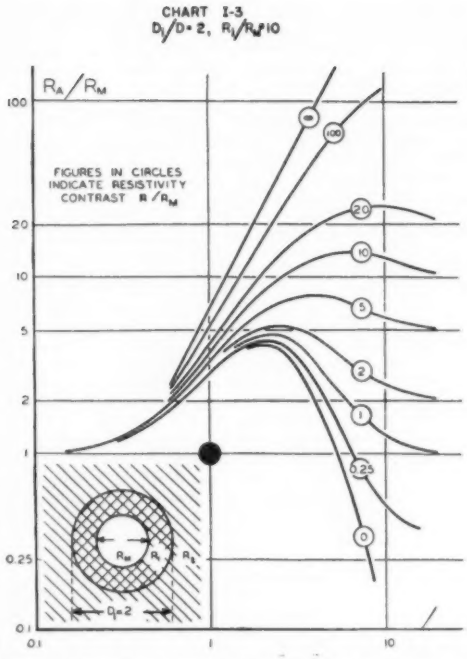


Fig. 9—Departure chart for mud-invaded formation and for three-electrode arrangements. (From Alpin.)

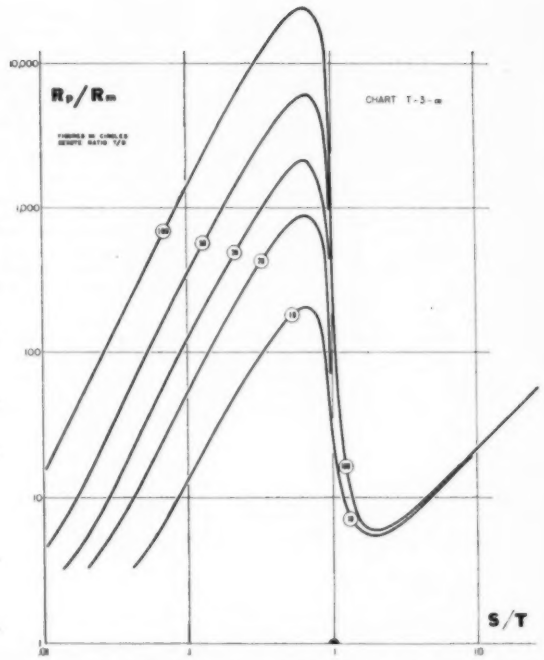


Fig. 10—Peak resistivity value for beds of infinite resistivity but finite thickness, for three-electrode arrangements.

order to increase the accuracy of the determination.

While Figs. 2 and 3 (called here Charts 2-OR and 3-OR, respectively) illustrate well the variations of optimum resistivity in terms of the other factors, they are not always convenient for the solution of certain problems because their use necessitates continual interpolations. This shortcoming can be overcome by presenting the data in a different manner.

True resistivity charts.—Figs. 4 and 5 are charts giving directly true resistivities in terms of optimum resistivities. They are called the TR charts. These charts give the desired data for various values of S/D. Inasmuch as the electrode spacings are standardized in a given area or field, and as the bit size is generally constant over long sections of hole, it is a simple matter to establish once and for all the curves for the usual S/D ratios. Then no interpolation is needed to determine simply the resistivity of beds for which the hole diameter is equal to bit size.

It should be noted that the OR and TR charts, as well as the HD charts discussed below, contain the same data but plotted in different ways. Any one chart can therefore be used, although for certain applications some are more convenient than the others.

Hole-diameter charts.—A number of petroleum-engineering problems require that the hole diameter be approximately known in certain parts of the hole. In many instances resistivity data can solve this problem. From the foregoing discussion it can be seen that, in principle, this is feasible when either one of the following sets of measurements is available.

1. { Mud resistivity.
   { Two resistivity graphs.
2. Three resistivity graphs.

A glance at the OR charts shows that, while there is a unique solution to the problem of determining true resistivities when the optimum resistivity and other factors are known, this is not so for determining the bore diameter. For certain ranges of R_t and S, there are cases where the same value of R_a corresponds to two values of D. Also, for very long electrode spacings there is usually indetermination. To avoid this indetermination very short spacings must be used, of the order of 1 ft. It should be remembered that when such short spacings are used the departure chart data available at the present time do not apply perfectly because the electrodes can no longer be considered as being small spheres. However, for most problems, cementing in particular, high accuracy is not required and the data here offered are generally sufficient.

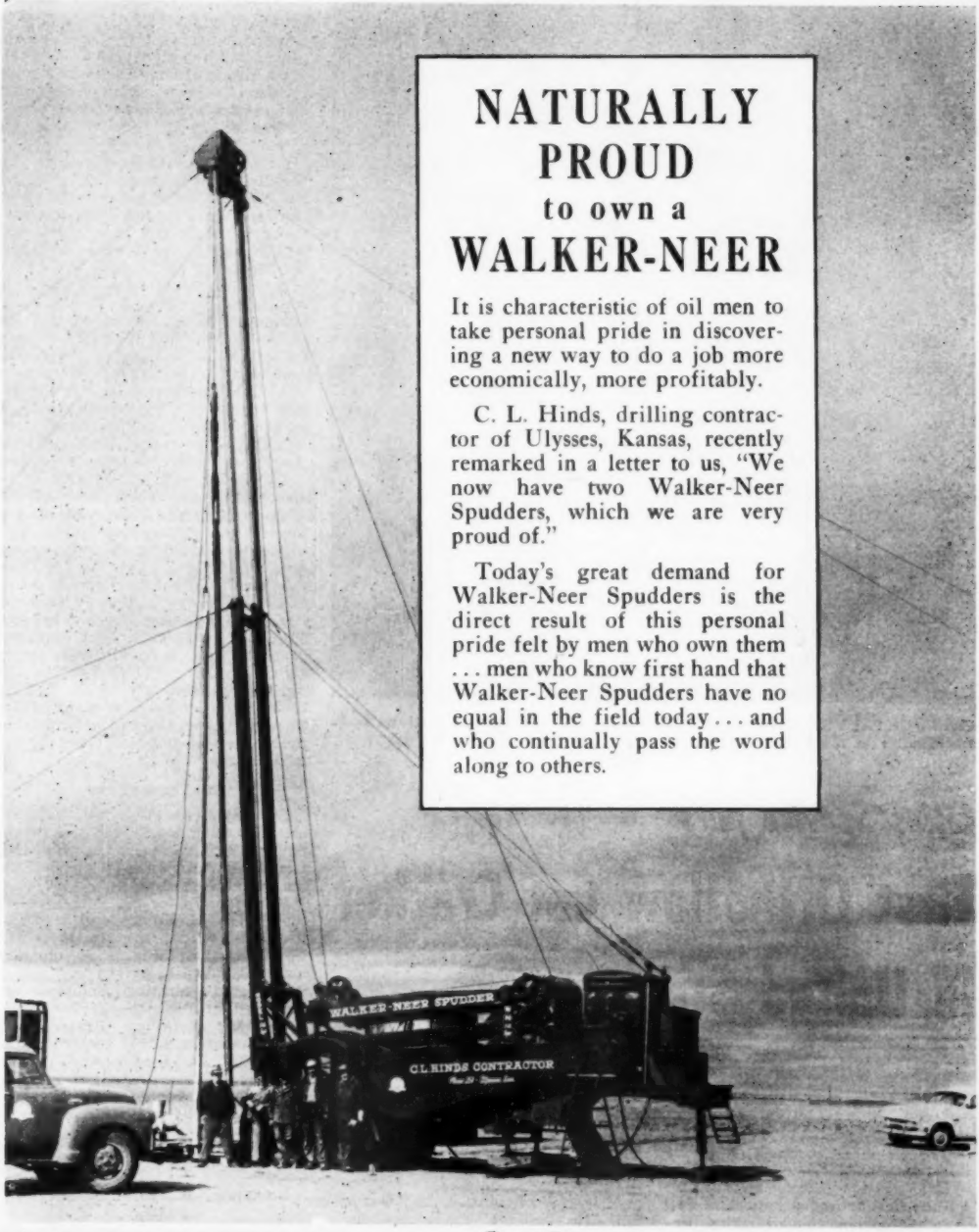
Figs. 6 and 7 represent the HD charts (hole-diameter departure charts) in the range where there is a unique solution. They are used like the OR charts, and an example of application will be given.

The problem is easily solved when the resistivity R_t of the formation of interest is known. This condition is met for a number of shale sections whose resistivity is uniform laterally over large distances and vertically over several hundred feet. Once the true formation resistivity is obtained in a well (with a long electrode spacing, for example) its value can be used without correction in the general area for determining the hole diameter.

When the mud resistivity R_m (corrected for ground temperature) is known fairly accurately, the HD chart gives readily the hole diameter from a single resistivity graph. On the other hand, when R_m is not known accurately enough it is necessary to have two resistivity graphs, both made with short spacings, S and S′.

Let R_a and R'_a be the average optimum resistivities thus obtained in a small section (5 ft., or more) of formation for which the resistivity graphs exhibit only small variations. Because the electrode spacings are so short the bed can be considered as being very thick and the departure chart data apply. The quantities R_a/R and $1/S$ on the one hand, R'_a/R and $1/S'$ on the other hand are computed. The two points having the foregoing coordinates are marked on a transparent paper on which the log-log

(Continued on page 210)



NATURALLY PROUD to own a WALKER-NEER

It is characteristic of oil men to take personal pride in discovering a new way to do a job more economically, more profitably.

C. L. Hinds, drilling contractor of Ulysses, Kansas, recently remarked in a letter to us, "We now have two Walker-Neer Spudders, which we are very proud of."

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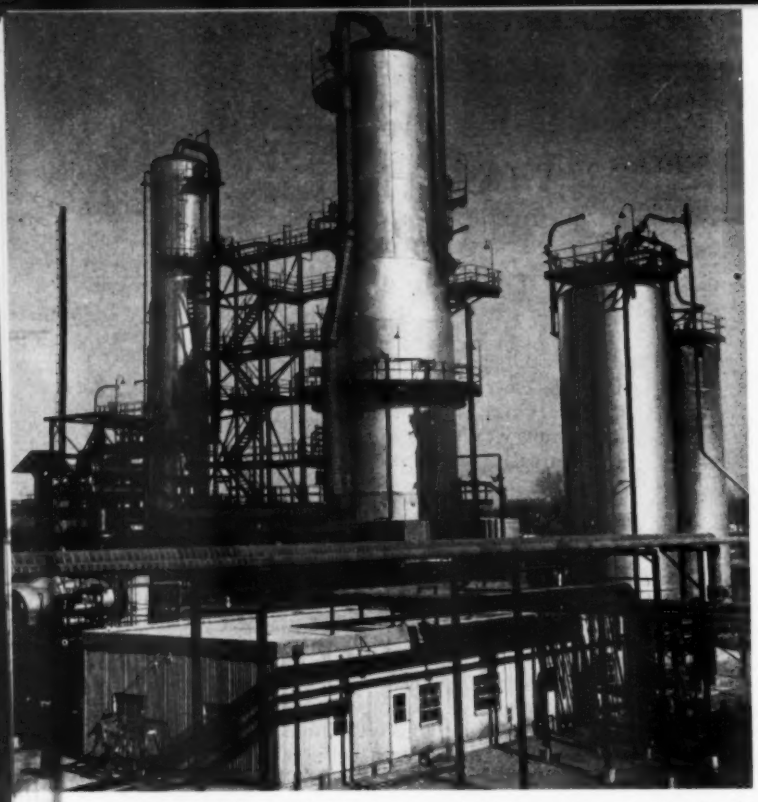


Fig. 1—CATALYTIC CRACKING.—New 8,350-bbl. per day cat unit and main fractionator at the Ponca City refinery of Cities Service Oil Co.

Cities Service puts

First Orthoflow Cat Cracker In United States

on stream at Ponca City

by John C. Reidel
District Editor

AS the first and most important step in the current modernization program at its Ponca City, Okla., refinery, Cities Service Oil Co. has placed on stream a new Orthoflow catalytic cracking unit designed by M. W. Kellogg Co. for a fresh-feed throughput of 8,350 bbl. per day. This is the first Orthoflow unit in the United States. A smaller installation, with a capacity rating of 3,000 bbl. daily, has been in operation since early summer of 1951 at British-American Oil Co.'s Edmonton, Alta., refinery.

Orthoflow catalytic cracking units operate on the same basic principles as the conventional F.C.C. process, but with several distinct changes in mechanical design. Orthoflow design is aimed at reducing the total height of the unit, thus eliminating some of the platforms and other auxiliary structural work. Over-all height of the Cities Service cat cracker is 116 ft. above grade. Costly welding of bends on outside catalyst lines is eliminated. With straight-line flow of catalyst through lines located inside the regenerator, and minimum pressure differentials across the catalyst valves, effects of erosion should be minimized.

Main features of the Cities Service installation at refinery are:

1. The reactor is set directly above the regenerator in the Orthoflow converter. The catalyst lines are set inside the regenerator to obtain straight-line flow.

2. "Needle-type" valves are used to control catalyst flow in the riser and standpipe. A double-disk slide valve in the regenerator vent line is used to hold back-pressure on the regenerator.

3. A stripper section is provided inside the reactor by installation of a curved partition plate in which slots, installed at an angle, permit catalyst flow from reactor to stripper section.

4. A cylindrical catalyst well or "inside hopper" is located at the bottom within the regenerator around the lower part of the riser pipe. This serves to separate spent and regenerated catalyst.

5. The main cat fractionator incorporates a slurry settler at its base. High-pressure steam is generated in a slurry boiler through heat exchange of boiler feed water with the slurry reflux stream.

6. The gas-recovery section consists of an absorber-stripper designed for 75 per cent retention of propane-propylene, a secondary absorber, and a debutanizer.

1—Process Flow

Design rate for the new Cities Service cat cracker is 8,350 bbl. per stream day of 30° A.P.I. gas oil prepared from West Kansas crudes plus 2,839 bbl. per day of recycle.

Main features of the unit, some of the design conditions, and principal instrumentation are indicated in the flow diagram of Fig. 5. A summary material balance is given in Table 1. Anticipated operating conditions are indicated in Table 2.

Catalytic cracking. — Arrows indicate circulation within the Orthoflow converter. Oil feed and dispersion steam enter through two side connections into the bonnet of the regenerated catalyst valve, PV-1, and travel up through the hollow stem of this valve. Total charge is made up of fresh gas oil, hot recycle gas oil from

TABLE 1—MATERIAL BALANCE

	Barrels per day	Vol. %	Pounds per hour	Wt. %
Fresh feed	8,350	100.0	106,600	100.0
Recycle gas oil	2,589	31.0	33,650	
Throughput	10,930	131.0	140,250	
Dry gas (M.c.f.d.)			8,320	7.8
Butanes	1,301		11,190	
Deb. gasoline	3,035	36.4	32,000	
Naphtha	1,140	13.6	13,640	
Light gas oil	1,670	20.0	21,450	
Heavy gas oil	435	5.2	5,960	
Decanted oil	400	4.8	5,340	
Coke			9,000	8.5

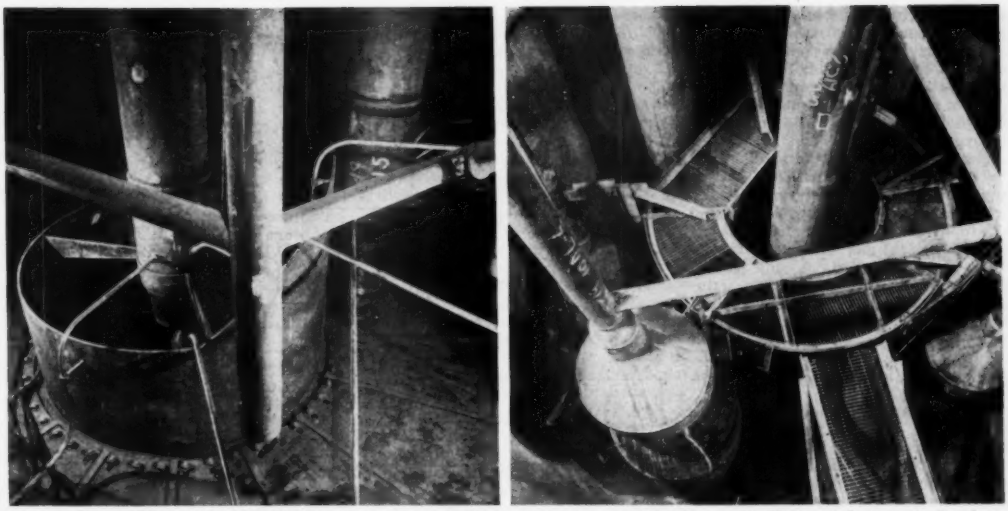


Fig. 2—REGENERATOR INTERIOR.—Two views inside regenerator of Orthoflow unit. Note catalyst control valves.

Fig. 3—INSTRUMENTATION.—This was carefully reviewed for the operators.

Fig. 4—TRAINING SESSION.—Cat cracker operators are following Louis G. Brannin, catalytic cracking supervisor, as he explains Orthoflow operation. (For story on Cities Service training program see The Oil and Gas Journal, February 25, 1952, page 134.)

main fractionator, and some hot slurry oil from settler. Hydrocarbon vapor, steam, and catalyst stream goes up riser pipe and through holes in the reactor grid to reactor catalyst bed. The stream of cracked hydrocarbon, steam, and inert-vapor leaves the reactor overhead by way of a single-stage cyclone. This stream is the feed to the base of the fractionator.

Spent catalyst flows from the reactor to the stripper section through slots cut in the partition wall separating the two sections. Rate of flow of stripped catalyst down the standpipe to the regenator bed is controlled by the spent catalyst valve, PV-2. Regenerated catalyst flows from the regenerator bed into the cylindrical well or "inside hopper," located at the bottom of the regenerator, and from this is conveyed by the stream of hydrocarbon feed and dispersion steam through slots in the lower end of the hollow stem of PV-1 valve, through its tip, to the riser inlet.

A two-stage cyclone is located within the regenerator. Flow of effluent gas from the regenerator is controlled by a double-disk slide valve (Sl. V.-1) in the vent line.

Main fractionator. — Slurry reflux, with part of its heat content removed in the slurry boiler, is circulated over baffles in the lower scrubbing section of the fractionator. In this section overhead vapors from the cat cracker are desuperheated and catalyst particles washed out. (The slurry settler is built into the base of the fractionator and separated from the column proper by a solid internal head. This design is also followed in older Kellogg units.)

Decanted oil pumpback to the fractionator is held at a rate that will maintain a catalyst concentration of about 0.5 lb. per gallon in the slurry

reflux. Net decanted oil goes to storage for blending into fuel oil. Thickened slurry joins the feed to the reactor. Tray 17, located between scrubbing section and heavy gas-oil drawoff pan, provides additional downflow for cooling and removal of entrained reflux slurry or catalyst.

Heavy gas oil is used to furnish heat to the debutanizer reboiler and is then returned in two streams: (1) To tray 15 above the drawoff pan, and (2) to tray 17 and the scrubbing section. The light gas oil drawn off tray 11 is steam stripped. A side stream furnishes heat for the absorber-stripper and is then returned as reflux to tray 9 together with rich oil from the secondary absorber. Unstripped naphtha is drawn off tray 5. (A naphtha stripper is to be installed at a later date.)

Gas recovery. — Fractionator overhead gases coming from the reflux drum by way of the compressor dry drum are compressed and mixed with rich oil from the absorption section of the absorber-stripper. The mixture is cooled before entering as feed to the absorber-stripper. The lean oil from this column is made up of refrigeration-cooled net overhead product from the fractionator combined with a recycle stream of debutanized gasoline. The absorber-stripper is designed for rejection of ethane and lighter and approximately three-fourths of the hydrogen sulfide, with retention of 75 per cent of the propane-propylene in bottoms.

Absorber-stripper tail gas goes to the secondary absorber for reabsorption of lean oil carried over from the absorber-stripper. Lean oil to the reabsorber is a light gas-oil side stream. Rich oil from the reabsorber goes back to the main fractionator.

Bottoms from the absorber-stripper make up the feed to the debutanizer, after being partially vaporized through heat exchange with debutanizer bottoms. The debutanizer produces a totally condensed propane-butane mixture overhead and light gasoline bottoms. A portion of the lat-

TABLE 2—OPERATING CONDITIONS

Type of feed stock: Gas oil from West Kansas crudes.
Type of catalyst: Synthetic.

Item	Quantity
Carbon produced, lb. per hour	8,100
Ratio carbon to feed (fresh) wt.%	7.6
Catalyst to oil ratio (fresh feed) wt. %	16.7
Space velocity	1.35
Catalyst circulation rate, tons	14.8
Reactor temperature, °F.	900
Regenerator temperature, °F.	1,080
Hydrogen in coke, wt. %	10
Slurry return (settled) bbl./day	250
Catalyst in slurry (reflux) lb./gal.	0.5
Steam to spent catalyst stripper lb./hr.	8,900
Steam to reactor, lb./hr.	1,400
Steam generated, lb./hr.	27,260
Total blower air, lb./hr.	114,900
Catalyst holdup in reactor, tons	44.2
Catalyst holdup in stripper, tons	14.40
Catalyst holdup in regenerator, tons	96.4
Carbon on spent catalyst, wt. %	1.0
Carbon on regenerated catalyst, wt. %	0.5
Conversion, vol. %	67

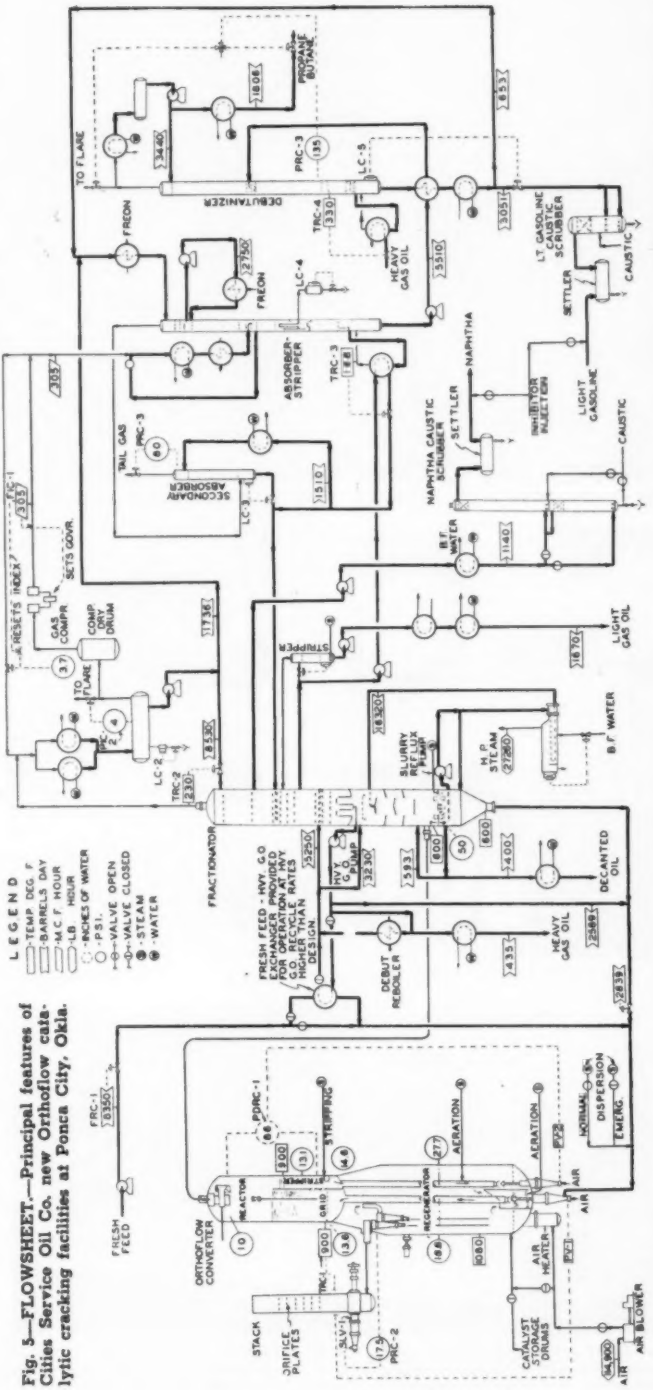


Fig. 5—FLOWSHEET.—Principal features of Cities Service Oil Co. new Orthoflow catalytic cracking facilities at Ponca City, Okla.

ter forms the recycle lean oil to the absorber-stripper.

2—Instrumentation

The usual problems incident to catalytic cracking operation had to be solved in the instrument-process design of the Cities Service unit. Chief of these are reactor temperature control, regulation of catalyst circulation rate, maintenance of catalyst bed levels, and control of air rate to regenerator.

Regenerator temperature.—Reactor bed temperature controller, TRC-1, controls catalyst flow to the reactor by regulating the position of the regenerated-catalyst valve, PV-1. For example, if the reactor bed temperature should drop below the set point, TRC-1 will act to open PV-1 and admit more hot catalyst to the reactor. Since the fresh feed and recycle stream rates are controlled by FRC-1 and FRC-2, a means is thus provided for relating catalyst-oil ratio and catalyst circulation rate directly to reactor temperature. A recorder which measures temperature in the regenerator vent line is provided with an alarm light and howler which go on at abnormally high regenerator temperature.

Catalyst flow.—Rate of steam flow to the stripper is controlled to maintain a less dense phase in the stripper than in the reactor. In normal operations the catalyst-bed level in the reactor is equal to that in the stripper so that when circulation rates are in balance catalyst flows through the slots in the partition plate into the stripper.

Controller PdRC-1 operates the standpipe valve PV-2 and thus directly sets stripper holdup. However, it also indirectly governs the reactor bed level. For a given stripper holdup the reactor catalyst holdup will be automatically that at which the rate of catalyst flow to the stripper equals the flow into the reactor. When catalyst circulation rates are in balance, flow rate from the bottom of the stripper is equal to that in the riser and to the rate at which catalyst flows through the partition slots into the stripper.

Catalyst-valve and slide-valve control is accomplished by means of limitorque units, air motors, and positioners.

Regenerator pressure.—Controller PRC-2 throttles the double-disk slide valve, Sl. V.-1, in the stack, to control regenerator pressure. Six perforated orifice plates in the stack take up most of the pressure drop in order to reduce the differential pressure across the slide valve. One side of the slide valve is controlled automatically. The other disk is hand operated and is adjusted at periodic intervals to a position such that both disks are equidistant from the center. This is to prevent uneven erosion of the disks.

Catalyst-valve differentials.—Operation of the Orthoflow unit is intended to be such that a minimum pressure differential will exist across the catalyst valves, consistent with maintenance of catalyst-bed level for the desired conversion. At the same time it is sought to balance the differentials across the two valves. Since the opening of the stack valve determines the regenerator pressure, this exerts a primary influence over the relative catalyst-valve differentials. If regenerator pressure is too low the differential across PV-1 will be too low while that across PV-2 will be too high. PRC-2 then functions to change the stack valve opening so that the catalyst-valve differentials are balanced. This is then the ideal operation in which the catalyst flow rate from the regenerator up to the reactor is the same as from the stripper down to the regenerator, thus maintaining constant reactor catalyst-bed level.

Differential pressure recorders.—Since the differential pressure over the entire height of the reactor vessel is indicative of catalyst-bed level a differential pressure recorder (not shown on flow sheet) is used to measure reactor catalyst holdup. Other recorders are used to measure differential pressure across the catalyst valves and over the entire regenerator height. A red-light-and-howler alarm system is provided with the catalyst-valve differential recorders to guard against too low valve differentials.

Air-blow control.—Air for catalyst regenerator is furnished by a four-stage centrifugal blower designed for maximum delivery of 138,000 lb. per hour of air discharging at 24 psig. at a speed of 4,650 r.p.m. The blower is driven by a ten-stage steam turbine. A manual indicating controller is located in the main instrument control building and tied in with a manual relay loading station located in the blower control room. Instrument air pressure from the relay is tied into an oil relay system which operates the turbine steam throttle valve. An overspeed trip on the turbine is provided.

3.—Mechanical Design

The controlling element of the catalyst valves is a conical plug raised and lowered with a matching seat. The seats are welded to the catalyst lines. The body of the valve is partly inserted into the regenerator and bolted in place to an external nozzle flange. The spent catalyst valve is solid and welded to the top of a hollow-stem tube. The regenerated catalyst valve is similarly welded but the conical plug is drilled through to the hollow stem. Oil feed and dispersion steam are introduced through a large inlet to the bonnet section of this valve. The stem tube of each valve is connected to a solid stem of smaller diameter through which gear mechanisms move the valve up or down.

Stripper slots.—The partition wall between reactor and stripper compartments in the upper section of the Orthoflow converter is constructed of steel plate which is curved away from the vessel wall when viewed from the top. Slots are 3 by 14-in. rectangular nozzles extending through the partition plate at 45° from the vertical into the stripper. Two of the slots are located just above the reactor grid and the remaining five at a height which is roughly one-third of the height from the grid to the top of the partition plate.

Cyclones.—Two single-stage cyclone separators are operated in parallel in the upper section of the converter. In the regenerator, three sets of two-stage cyclones are hooked up in parallel (each set has two cyclones in series flow). The inlet to the first separator in each set is extended by a vertical duct to increase the amount of disengaging height within the vessel and to eliminate dead zone in the top of the vessel.

Inside hopper.—The cylindrical catalyst well located at the bottom of the regenerator around the regenerated catalyst line stands 3 ft. high above the grid on one side and 6 ft. high on the side nearest the spent-catalyst pipe. This design is to prevent channeling of spent catalyst from the spent-catalyst pipe directly to the cylindrical well. Aeration steam enters through a circular steam distributor located at the bottom of the well.

Water sprays.—Boiler feed water is used in the sprays for control of afterburning. Sprays located in the dilute-phase section toward the top of the regenerator consist of "normal" sprays to be used continuously during operation and a set of "emergency" sprays to be used if serious afterburning should occur. A set of "emergency" bed sprays is also located 2 ft. above the grid for prevention of excessively high regenerator temperature.

BOOK

TECHNICAL PUBLICATIONS 1949. Edited by Arman E. Becker. Published by Standard Oil Co. (N. J.) 563 pp.

The 24 articles reprinted in this fourth volume of this work, together with the list of other papers published in technical journals during 1949 by members of Standard Oil Co., (N. J.) and affiliated companies, will give the reader some idea of the diversity of the technical problems which confront the petroleum industry. Purpose of the book is well explained in a foreword by Eugene Holman, president of Jersey Standard, in his words: "Geologists, chemists, physicists, engineers, and mathematicians are daily applying their knowledge to help locate new oil fields, devise better production and refining methods, improve transportation and distribution practices, and develop products of greater utility. It is largely by their efforts that the oil industry has been able to supply more and more products to more and more people year after year. It is our hope that this series of Technical Publications may be helpful and stimulating to young scientists and engineers who are considering one of the many interesting phases of petroleum technology as a career."

Downtime Decreased

Aligning shafts from rotating axes instead of external surfaces shortens downtime by as much as 2,000 per cent

DOWNTIME has been decreased as much as 2,000 per cent by application of a method involving alignment of shafts from the rotating axes rather than from external surfaces.

Developed by W. H. Weaver, maintenance superintendent at Phillips Petroleum Co.'s Fullerton, Tex., plant, the method eliminates misalignment caused by crooked shafts and worn or eccentric bored couplings.

Weaver's suggestion won the grand prize at the recent "Operating Kinks" session at the Permian basin regional meeting of Natural Gasoline Association of America in Odessa, Tex.

How it works.—The method works on the principle that a shaft supported in two places, when rotated, turns on an axis located in the center of the shaft at the bearings where supported. The rotating axis will not be in the true shaft center, except at the support points, if the shaft is bent or sprung. When two shafts are aligned by this method, each shaft supported by two bearings, the rotating axis through the four bearings will be on a line, both vertical and horizontal. This method will show the angular deflection and vertical or horizontal misalignment of shafts from the rotating axis at the coupling.

To further explain the method, visualize a shaft being supported by two bearings, as are pumps, electric motors, and turbines. If a clamp with an arm projecting in line with the clamp is attached to one end of the shaft, the arm will be perpendicular to the shaft. When the shaft is rotated the clamp arm will rotate on the rotating axis regardless of the amount of kink in the shaft.

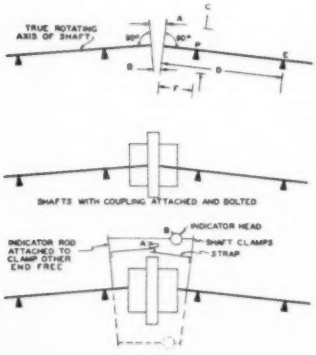

TRUE ROTATING AXIS OF SHAFT
SHAFTS WITH COUPLING ATTACHED AND BOLTED
INDICATOR ROD ATTACHED TO CLAMP OTHER END FREE
INDICATOR HEAD
SHAFT CLAMPS
STRAP

Fig. 1.

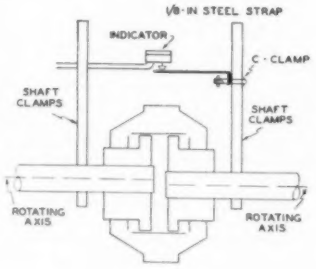


Fig. 2.

When two shafts are to be aligned, a clamp is placed on the end of each shaft and the coupling connected so the shafts will rotate together. By placing indicators on the clamp arms the amount of misalignment can be measured. Then definite steps can be taken to correct the misalignment.

Measuring misalignment.—The angular misalignment (Fig. 1) can be measured in both the vertical and horizontal planes when an indicator is placed between the clamp arms at point (A) and rotated to position (B). This will record the amount of deflection between the shafts rotating axes in the distance (C).

By turning the two shafts 360° a maximum and minimum distance between the arms will be found, these will be 180° apart. Attaching a piece of flat bar stock approximately ⅛ by 1 in. to one of the clamp arms with a small "C" clamp, then attaching an indicator to the other clamp arm, so placed that the indicator point will be in the approximate position of the shaft arm, the indicator will give the amount of deflection between the rotating axes when the indicator reading is divided by 2.

By referring to Fig. 3 it will be noted that (A), (B), and (C) are equal. When the assembly is rotated the indicator will record (A) plus (C) which is twice (B). Therefore the indicator reading must be divided by two to determine the true value of the distance (B). If one shaft is required to be 0.010 in. low or high from the other shaft the indicator reading will be 0.020 in. when the assembly is rotated through 180°.

In Fig. 1, indicator A records misalignment of shaft ends, while indicator B records the angular deflection between shafts. Referring to the top sketch of Fig. 1:

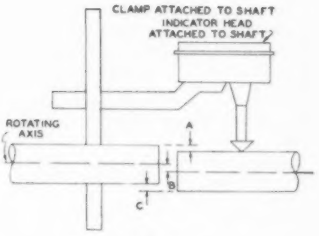


Fig 3.

A — B = deflection in distance "C."

(A — B)/C = deflection per inch.

Deflection per inch × distance "D" = correction at point "E."

Deflection per inch × distance "F" = correction at point "P."

Successful.—This method has been used for 3 years. To illustrate its success the following example is given:

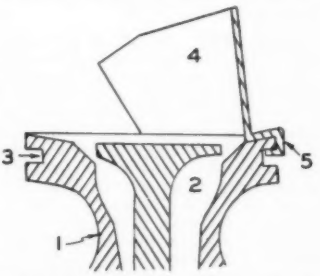
At Fullerton a multipump unit, driven by a 150-hp. electric motor at 3,580 r.p.m., is in service. Prior to the employment of the axial shaft-alignment method, this unit was shut down at least once a month to replace packing or bearings in one or more of the pump units. This necessitated shutting down the distillation unit approximately 4 hours each time, resulting in a loss of about 12,000 gal. of product.

The unit was checked repeatedly using the straight edge and taper-gage method on the couplings. They appeared to be in alignment.

When aligned by the method outlined above, the pump operated 20 months before a shutdown. This shutdown was made to replace packing. Therefore the saving realized amounted to 240,000 gal. of product.

Fog-Nozzle Shield Adds to Fire-Fighting Effectiveness

The effectiveness of fire-fighting equipment at Shell Oil Co.'s Notrees, Tex., plant has been increased by



Standard fog nozzle with new deflector.

the addition of deflector shields on the fog-spray nozzles.

This device was developed by J. F. Revier, electrician, who has observed that fog-nozzle spray directed against the surface of burning oil causes agitation of the oil. This is due to the lower part of the stream striking the surface at a sharp angle and high velocity. Such agitation facilitates burning and hinders fire fighting.

To prevent this, a metal shield was welded to the nozzle as shown on the attached drawing. When fighting a fire burning on an exposed liquid surface, the nozzle is held with the shield on the bottom side. As the fire fighters approach the burning liquid from a low angle the deflected stream from the nozzle sweeps across the surface to force the fire into a smaller area. This permits the spray from the top side of the nozzle to cool the liquid and extinguish the flame.

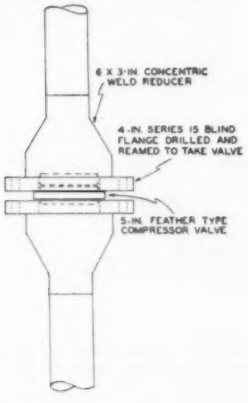
The standard fog nozzle (1), has an adjustable deflector (2), and an annular groove (3) at the front. The deflector (4) is made of thick sheet metal. It is clamped or welded to the nozzle by bending the rear part into the groove and fastening as shown at (5).

This idea was submitted by Revier at the "Operating Kinks" session at the recent Permian basin regional meeting of the Natural Gasoline Association of America, Odessa, Tex.

Positive Check Valve Prevents Air Leakage

To prevent excessive instrument air leakage, Hugh Smith and George Zorns, superintendent and chief operator, respectively, for Phillips Petroleum Co., at the Hobbs, N. M., plant, have devised a positive check valve.

Two 4-in. series 15 blind flanges were drilled and machined so as to take a 5-in. feather-type compressor valve. A 6 by 3-in. concentric-weld reducer was welded to each flange and also to the piping. These materials were readily available; any desired combination of materials can be used.


6 X 3-IN. CONCENTRIC WELD REDUCER
4-IN. SERIES 15 BLIND FLANGE DRILLED AND REAMED TO TAKE VALVE
5-IN. FEATHER TYPE COMPRESSOR VALVE

The check valve has been in service for several months and has given excellent trouble-free service. It is installed on an instrument air compressor which utilizes half of a compressor driven by a Type VIII Bessemer engine.

This idea was submitted by Smith and Zorns to the "Operating Kinks" session of the recent Natural Gasoline Association of America Permian basin regional meeting at Odessa, Tex.

Dryness Tester

Liquid propane moisture determined continuously

A SIMPLE device, operated on a continuous basis, is in use at the Notrees, Tex., plant of Shell Oil Co., for rapid dryness testing of liquid propane.

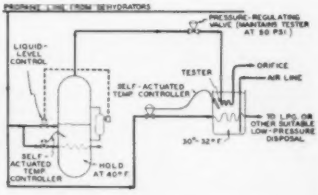
The method was devised by W. L. Covington and W. A. Allexson, chemist and assistant superintendent, respectively, at the Notrees plant. It is a distinct improvement over the older time-consuming batch method.

Entered in the measurement division of the "Operating Kinks" session of the Permian basin regional meeting of the Natural Gasoline Association of America, at Odessa, Tex., this idea was judged first-place winner.

How it works.—The continuous propane dryness tester is installed in a manner which will allow a small side stream of dried liquid propane from dehydrators to be directed through the testing apparatus. The tester consists of two essential parts, one of which includes a small vaporizing chamber with controlled liquid level and temperature. The propane liquid and vapor reach equilibrium at 40° F.

The second part is a modification of the conventional cobalt bromide propane dryness tester in which the bath is maintained at a constant uniform temperature (30°-32° F.) by use of a coil through which liquid propane is expanded. Agitation is obtained by use of an open air line extending to the bottom of the bath. A pressure-controlling regulator is used to maintain the 50 lb. pressure required by the conventional cobalt tester immersed in the automatically controlled bath. A solution of antifreeze is used in the bath.

When the continuous tester is in operation the liquid propane enters the vaporizing chamber (where the temperature is automatically controlled at 40° F.), vaporizes, and the vapors pass through the regulator to the cooling coil, contact the cobaltus bromide indicator, and exhaust through the orifice to atmosphere.



Apparatus for continuous-moisture determination.

If the cobaltus bromide indicator remains green or blue the propane is said to meet dryness specifications.

Boiler Key-Cap Installer Eliminates Hammer Damage

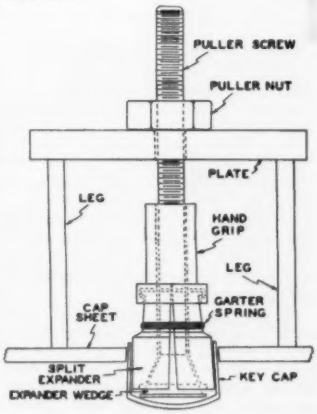
H. C. Ratto, roustabout for Phillips Petroleum Co., at Odessa, Tex., has developed a "puller" type tool for the installation of key caps in the cap sheet of shipping-board boilers.

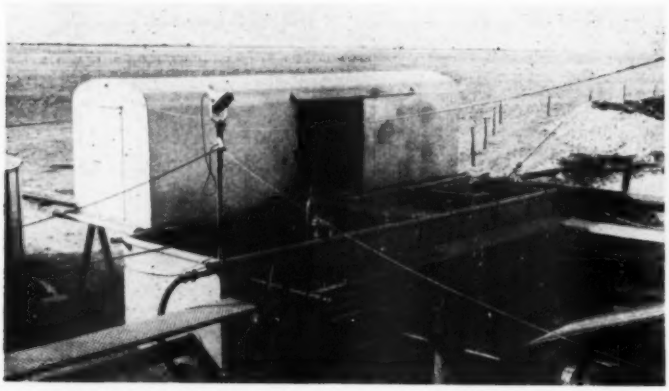
The tool inserts, and expands, to a tight fit the key caps at the boiler tube end in the cap sheet.

It permits all caps to be drawn into cap sheet as opposed to sledge hammering. It eliminates rolling of leaky caps, reduces a two-man to a one-man job, reduces time necessary for this operation by 50 per cent, eliminates sledge-hammer damage to caps, straightens bent caps, and eliminates the safety hazard of manipulating a sledge hammer in a semiawkward position.

The tool has proved itself in use.

Ratto submitted his idea to the "Operating Kinks" session of the recent Permian basin regional meeting of Natural Gasoline Association of America.





IT'S PORTABLE.—This all-steel building where drilling mud is stored at Phillips Petroleum Co.'s rig is easy to move. It is shown beside the mixing tank on substructure.

Steel Mud Building

Resembling a railroad box car, it provides safe place for storing dry mud for rigs of Phillips Petroleum Co.

DRY mud for Phillips Petroleum Co.'s drilling rigs is always ready for instant use because it is kept in perfect condition, thanks to a handy all-steel building fabricated especially for its storage.

Resembling a railroad box car, the building, which can be moved easily, is set alongside the mud-preparation tanks. An all-welded unit of tank steel, it has large barn-type sliding doors built into each side at the midsection. The doors are supported with rollers and a track at the top, and are protected by a rain-deflector welded to the building at the roof edges.

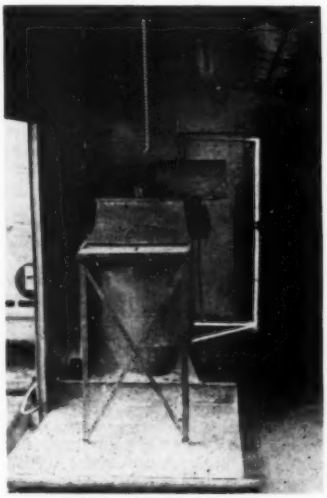
Average-sized single doors are set into each end so that men can enter without opening the larger doors.

Skid mounted.—The structure is skid mounted to provide means of support and to facilitate moving. Floor of the unit is at the same level of the side rails of the mud tank, making passage easy from the building onto the rig structure.

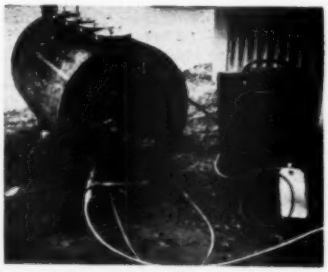
Supporting the building is a pipe arrangement similar to a carpenter's "saw-horses." These horses rest on cribbing or oil-field planking laid on the ground.

Mud is stored in stacks along the walls. The bag slitter, in combination with a mixing device, sits beside the large door which opens on the mud-mixing tanks. Fluid piping is set permanently through the wall of the building at the desired point and connection to outside lines is made with conventional unions.

Men detailed to mix a batch of mud can do the job in record time—in any weather.



MIXING. — Dry mud additives are mixed with proper fluid proportions inside weatherproof storage house beside mixing tank.



SHELL'S mud-testing equipment.

Electro-Chemical Action of High pH Mud Is Evaluated

Electro-chemical action of relatively high pH drilling mud on various types of bridging plugs was recently evaluated under simulated reservoir conditions by Shell Oil Co. in Elk City field, Oklahoma. Sections of magnesium and cast-iron bridging plugs were placed in the horizontal test tank which contained prepared drilling mud. (See cut.)

By means of the gas-firing controls (in foreground) the tank contents were brought to a temperature equivalent to bottom-hole conditions.

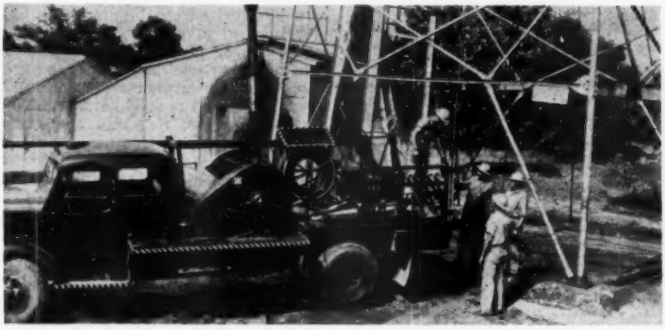
The bath was held at constant temperature by means of the electrically controlled temperature controller. This instrument was preset to the bottom-hole-temperature reading.

Safety Program

Stanolind employes work safely in the fields

WORKING in an oil field for an organization like Stanolind Oil & Gas Co. is safer than working in textile mills, food plants, stores, or in

CODE COLORS.—Marvin T. Pettyjohn, shop foreman for Stanolind Oil & Gas Co., directs Merle E. Lamb in painting approved code colors on a new truck.



PULLING RODS SAFELY.—Gang pusher and crew plan to pull pumping rods from a Stanolind well. Note safety coding used on the truck.

many other seemingly "safer" places.

In spite of the potential hazards of work around tall derricks, heavy equipment, fast-moving machinery and gas and oil under high pressure, employes of Stanolind and other progressive oil companies have only half as many lost-time accidents as do the average American industrial workers.

Planning the job.—Principal emphasis in Stanolind's safety training is on planning to do a job safely before the job is started. Supervisors and men plan together the safe way of doing each job. Safety helmets, safety shoes, guards for moving equipment, handrails, and safety belts for high work are all used whenever the advance planning shows they are needed.

Equipment color-coding.—Another aspect of of the Stanolind plan is the color coding of equipment on which potential hazards exist. As shown in the photographs a seismograph recording truck is being provided with safety markings. These include color warnings on footboards, on moving parts of cable reels, and around gas tank filler pipe. Other equipment is coded similarly at danger points.

Each week Stanolind field employes attend a ½-hour safety meeting on company time. Field supervisors and foremen plan and conduct these meetings. Drivers of company cars and trucks get special safety training. Most of the older employes have already had first-aid training.

New field men are given a first-aid course on company time.

Core Boring Used in Marine Foundation Investigations

In foundation investigations for offshore-drilling structures in the Gulf of Mexico, an increasing number of oil companies insist on exploring each platform site by means of at least one core boring. Foundation designs are based on interpretations of soil tests on cores from the boring.

Borings for any major structure must be at least 200 ft. and sometimes 300 ft. in depth. Drilling and securing of undisturbed samples from deep borings in open Gulf waters can be accomplished only from a stationary platform.

The most frequently used scheme for erection of coring platforms makes use of a small-scale replica of the oil-well platform. It consists of a prefabricated jacket made of steel pipe and is supported by four pipe piles driven through the jacket legs.

A derrick barge is utilized for erection and removal of the platform.

Well-Head Defroster Keeps Christmas Trees Ice-Free

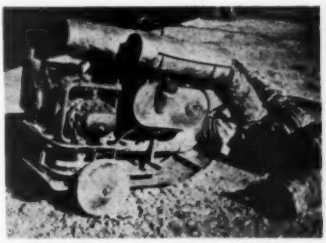
Hydrate formation brought about by pressure drop and other factors often cause christmas-tree heads to freeze up in areas producing from deep gas-condensate reservoirs such as the 10,000-ft. Hoxbar formation at Elk City field, Oklahoma.

A frozen well-head causes a temporary loss in production, and to alleviate the condition and restore the well to production, Shell Oil Co. employed the portable gasoline-burning heater shown in the above photograph.

The heater is equipped with a supercharged turbine-type blower which flows the heated air into a special jacket placed over the entire christmas tree. The combustion unit is hermetically sealed to keep exhaust gas and fumes from mixing with the heated air. The unit has a rated thermal output of 100,000 B.t.u. per hour.

Field usage indicates that approximately 1 hour is required to thaw out a well-head tree in Elk City field. Results obtained from the use of the first unit have been satisfactory and Shell has ordered a second heating unit of the same capacity.

The heating unit is a war-surplus item and currently sells for about $225.



DEFROSTER keeps Shell Oil Co.'s christmas trees free of ice in Elk City field, Oklahoma.

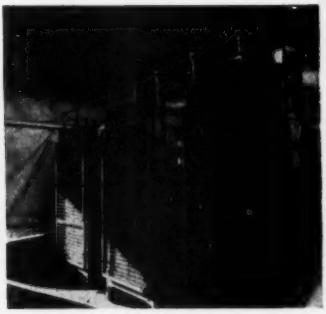
Wilshire Oil Co. Pipes Water to Field Radiators

Ordinarily radiators on gasoline engines used for powering drilling rigs are filled by hand. This calls for quite a bit of attention from the operator, and the work of filling is both time-consuming and awkward.

Drilling crews of Wilshire Oil Co. in Midkiff Field, Upton County, Tex., have installed a setup which greatly simplifies this procedure.

Water is piped under pressure to a header installed directly above the radiators. An individual filling line with shutoff valve is provided for each unit. Thus the operator may check and fill each radiator to the desired level in a short time.

The piping arrangement is quite simple, yet flexible. As shown in the accompanying picture, necessary bracing is provided at the radiator. Unions are installed between radiators to permit easy addition or removal of units. Tees are provided in the piping system wherever advantageous.



WATER-PIPING arrangement on radiators used by Wilshire Oil Co. in Midkiff field, Texas.

QUESTIONS on TECHNOLOGY

by W. L. Nelson
Consulting Engineer

Yields in Viscosity Breaking Part 2—Viscosity of Cracked Fuel Oil

Note: In the March 10, 1952, issue of this page (p. 129) a general method of computing gasoline and distillate yields was introduced and a table of the yields obtained when producing 22 A.P.I. cracked distillate was presented.

The gasoline yields shown in Table 1 when withdrawing an 18° A.P.I. cracked distillate during viscosity breaking is based purely on the degradation of A.P.I. gravity that occurs during thermal cracking. It tells nothing of the viscosity of the residual cracked fuel oils that are produced, and, of course, this is a primary consideration because too high a viscosity means that some of the supposed yield of cracked distillate must be used to "cut back" or dilute the residual cracked fuel.

The residual cracked fuel oil or tar is composed of two parts: (1) lightly cracked or nearly straightrun asphaltic material which has a very high viscosity, and (2) a very thin polymer or resinous material which is produced from the cracking of gas oil or distillable parts of the feed stock. Thus, when cracking charge stocks that have a gravity of about 18° or more, no difficulty is encountered with the viscosity of the cracked tar because it consists largely of the low-viscosity polymer. Fuel-oil gravities of 3°-5° A.P.I. are regularly attained (after cut back) when cracking residual stocks of 18°-25° A.P.I. gravity.

With charging stocks that have a gravity between 10° and 18° A.P.I., the situation tends to become confused. If the straightrun asphaltic material is only mildly cracked, it has a very high viscosity, nor is much cracked tar present in the fuel oil as a dilution agent because little cracking is conducted. By mild cracking, fuel-oil gravities only a few degrees A.P.I. (1°-3°) below those of the charging stock can be attained, and still meet the viscosity requirements of the cracked fuel oil. At the other extreme, if cracking is vigorous (producing much recycle stock and much thin polymer) or if the straightrun material is flashed to what would be a pitch (also producing much recycle stock), the resultant cracked fuel oil is rich in polymer which dilutes the pitch, and much lower gravities, even 5-7 are possible. As one illustration, a 13.8° A.P.I. paraffinic Mid-Continent residue was cracked to a 12.5° A.P.I. (300 viscosity after cutting) fuel oil with a yield of only 24 per cent gasoline, but when cracked to a 4.7° A.P.I. fuel oil (300 viscosity) the yield of gasoline was over 36 per cent. In the first operation the feed was degraded by only 1.5° A.P.I. but in the second by 9.1° A.P.I. Recycling of all of the cracked gas oil was practiced in both cases, and it is interesting to note that the liquid volume recovery exceeded 100 per cent, being nearly 105 per cent in the second operation.

Finally, such a low gravity of cracked fuel oil can be produced that the amount of cutter stock required is said to be prohibitive. The author of this page has not been able to verify several situations of this kind that have been reported but there is some indication of such a behavior at fuel gravities of minus 5° to 0° A.P.I. in the yields shown in "Yields in Noncoking Cracking" *(this page, February 25, 1952, page 183)*.

Thus, the gravity of cracked fuel oil that can be obtained in viscosity-breaking operations is a function of at least three variables (1) viscosity of feed stock and the related viscosity of cracked fuel oil or the amount of cutter stock required, (2) characterization factor of feed stock, and (3) most important of all, the degree or extent of cracking conducted. The

TABLE 2—APPROXIMATE OBTAINABLE GRAVITIES OF CRACKED FUEL OILS*

A.P.I. of charge stock	Characterization factor	A.P.I. gravities of fuel oils: Complete cracking†	With-drawing cracked distillates	Mild cracking‡
20	11.2	low	0-2	2
	11.8	5.0	5-8	9
18	11.2	low	1-4	4
	11.8	6.0	7-10	10
16	11.2	1.0	2-5	5
	11.8	7.0	8-10	10
14	11.2	2.5	3-6	6
	11.8	7.0	8-11	11
12	11.2	4.0	5-7	7
	11.8	8.0	9-12	11
10	11.2	7.0	7-10	9
	11.8	9.0	10-11	10

*Making 300 Furol at 122° F. viscosity after cutting. †Recycling all distillate or recycle stocks, flashing to a low gravity, and cutting back to 300 viscosity. ‡Recycling all distillate, flashing feed stock after scarcely any cracking, and with little cutback for viscosity.

TABLE 1—PERCENTAGE OF 400° E.P. (10 R.V.P.) GASOLINE BY VISCOSITY BREAKING—PRODUCING 26° A.P.I. DISTILLATE

	A.P.I. of fuel oil	Yields of gasoline for these gravities (A.P.I.) of cracking stocks: 8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Zero % distillate	0	25.8	27.4	29.0	31.6	34.2	36.8	39.4	42.0	43.8	45.6	47.4	49.2	51.0	52.4	53.8	55.2
	5	16.6	18.8	21.0	24.0	27.0	30.0	33.0	36.0	38.0	40.0	42.0	44.0	46.0	47.8	49.6	51.4
	10		4.0	9.0	12.6	16.2	19.8	23.4	27.0	29.4	31.8	34.2	36.6	39.0	41.1	43.2	45.3
	15						2.0	8.0	12.0	15.4	18.8	22.2	25.6	29.0	31.4	33.8	36.2
	20											4.0	9.0	13.0	16.5	20.0	23.5
10% distillate	0	22.6	25.0	27.4	29.2	31.0	32.8	34.6	36.4	38.2	40.0	41.8	43.6	45.4	46.8	48.2	49.6
	5	13.8	16.6	19.4	21.8	24.2	26.6	29.0	31.4	33.4	35.4	37.4	39.4	41.4	43.2	45.0	46.8
	10		3.0	7.4	10.6	13.8	17.0	20.2	23.4	25.8	28.2	30.6	33.0	35.4	37.5	39.6	41.7
	15							5.0	9.4	12.8	16.2	19.6	23.0	26.4	28.8	31.2	33.6
	20											1.0	7.0	11.4	14.9	18.4	21.9
30% distillate	0	11.4	13.8	16.2	18.0	19.8	21.6	23.4	25.2	27.0	28.8	31.6	32.4	34.2	35.6	37.0	38.4
	5	4.6	7.4	10.2	12.6	15.0	17.4	19.8	22.2	24.2	26.2	28.2	30.2	32.2	34.0	35.8	37.6
	10			0.2	3.4	6.6	9.8	13.0	16.2	18.6	21.0	23.4	25.8	28.2	30.3	32.4	34.5
	15								4.2	7.6	11.0	14.4	17.8	21.2	23.6	26.0	28.4
	20												4.0	8.2	11.7	15.2	18.7
50% distillate	0		2.6	5.0	6.8	8.6	10.4	12.2	14.0	15.8	17.6	19.4	21.2	23.0	24.4	25.8	27.2
	5			1.0	3.4	5.8	8.2	10.6	13.0	15.0	17.0	19.0	21.0	23.0	24.8	26.6	28.4
	10						2.0	6.0	9.0	11.4	13.8	16.2	18.6	21.0	23.1	25.2	27.3
	15									2.5	6.0	9.5	13.0	16.0	18.4	20.8	23.2
	20												1.0	5.0	8.5	12.0	15.5
70% distillate	0								2.8	4.8	6.8	8.8	10.8	12.8	14.0	15.2	16.4
	5								3.8	5.8	7.8	9.8	11.8	13.8	15.6	17.4	19.2
	10								1.8	4.2	6.6	9.0	11.4	13.8	15.9	18.0	20.1
	15										0.6	4.0	7.4	10.8	13.2	15.6	18.0
	20													1.8	5.3	8.8	12.3

effect of viscosity of feed stock is indicated by Mithoff, McPherson & Sipos *(The Oil and Gas Journal, November 6, 1941, page 81)* but not in the viscosity ranges that are of much value for viscosity breaking operations *(also see this page June 29, 1950, page 88)*.

It is obvious that the withdrawal of cracked distillates or recycle stocks robs the cracked fuel oil of low-viscosity polymer tar and accordingly the gravities of the cracked fuel oils must be higher than when only gasoline is produced. However, cracking must be extensive when cracked distillates are produced or the operation merely becomes one of high-temperature distillation. Several of the investigations that have been reported in the literature under the title of viscosity breaking, have pertained more to distillation than to cracking. The larger the withdrawal of cracked distillate the higher the gravity of the cracked fuel oil. Thus, with respect to Table 1 herein and when cracking a 15° A.P.I. charge stock, the cracked fuel could have an A.P.I. gravity of 7° when producing only 10 per cent of distillate (30 per cent gasoline), but when producing 70 per cent of distillate the gravity of the cracked fuel could only be about 10° or 11° (13 per cent gasoline).

At the present, not altogether satisfactory state of knowledge, only the suggestions of Table 2 regarding the gravity of cracked fuel oils can be offered.

Geophysical Prospecting In 1951

(Continued from page 123)

sonnel has been dealt with at such length because it is critical in determining whether the need for geophysical service by the oil industry can be met in quality and quantity. We need more well-trained and experienced men for the operations in being. We will need still more if we are to expand the operations to meet the apparent demand.

Seismograph Activity

North America contributed the major component to the 20.4 per cent increase in the world total of seismograph operations during 1951, the actual increase being 1,519 crew-months for a 1951 total of 8,248. For Canada the increase was 286 and for Mexico 90. Percentagewise the increase was greatest for Mexico (66.7 per cent). Canada was next with an increase of 23.9 per cent and that for the United States was 21.8 per cent, or somewhat, but not markedly, above the average world increase. The trend away from the United States noted in the report for 1950 was clearly reversed last year. There was a less than average increase in the Eastern Hemisphere and a small decrease in volume in South America. The greatest percentage increase occurred in Africa, where activity more than doubled, and the greatest decrease, both numerically and in per cent, took place in the Far East. This decrease is probably closely related to the unsettled political situation in that area.

The world distribution of seismograph operations in 1951 is shown in Fig. 2. The pie is larger than for the preceding year but no major change in the size of the slices is apparent. Here and in the other charts the plus and minus signs indicate whether any given slice is larger or smaller compared to 1950.

Domestic operations.—In the United States the 1951 increase in seismograph operations amounted to 1,172 crew-months. The Rocky Mountain states, Louisiana, and Texas accounted for nearly all of it, and in the order named, the increases being 570, 303, and 241 crew-months and 46, 41, and 10 per cent, respectively. The geographic distribution of seismograph operations in the United States in 1951 is shown in Fig. 3. Texas retains its commanding lead, but by a reduced margin. As will be noted, Texas, the Rocky Mountain states, and Louisiana accounted for approximately 83 per cent of the seismograph work done in the United States last year. Among the Rocky Mountain states activity was most concentrated in New Mexico, Wyoming, Colorado, and Montana, in that order, and these states were the seat of over 75 per cent of the activity in this area.

Gravity Effort

Gravity operations the world over rose moderately during 1951 from a level of 1,320 crew-months in 1950 to a total of 1,481. As will be seen by reference to Fig. 4, over half of such work last year was done in the United States, which accounted for practically the entire world increase. The downward trend in evidence in United States operations for several years back was definitely reversed and at year end they were substantially at the highest level of the year. In Canada gravity work was done in practically the same volume as the year before and therefore its contribution to the world total declined. Considerable gravity work was done in Mexico last year, and it more than doubled its percentage share of the world effort. As was true also in seismograph operations, the greatest decline in gravity work was experienced in the Far East. Other shifts are readily apparent from the chart.

United States operations.—The geographic distribution of gravity operations in the United States in 1951 is shown graphically in Fig. 5. Out of a total of 802 crew-months reported for the country, Texas, with 36.7 per cent, continued to hold the No. 1 spot. There was a relatively pronounced gain in Louisiana to a level about equal to that of the Rocky Mountain states. Among them these three areas accounted for over 84 per cent of domestic gravity operations last year. The greatest gain occurred in Louisiana, more particularly in coastal Louisiana, and the greatest relative loss was recorded for Mississippi.

Magnetics

Again it is impossible to make a report on magnetometer operations on a basis comparable with the other activities. Data received do not differentiate between ground party and aeromagnetic crew-months, and since ground parties may use a variable number of instruments, the meaning of ground crew-months is correspondingly indefinite. Since aeromagnetic and ground parties involve cost ratios of the order of 10 to 1 and data production in ratios of the order of 100 to 1, the problem of keeping track of even trends becomes somewhat complicated. To date your committee has had no success in providing you good data for magnetometer operations. It is probably true, however, that much more magnetometer work was done by and for the oil industry last year in comparison to those immediately preceding.

Economics

For its geophysical operations in 1951 the oil industry probably spent not less than $300,000,000 and possibly as much as $350,000,000. The bill for 1951 is greater in part because of substantially greater volume and in appreciable part because of greater unit costs.

Preliminary figures for 1951 indicate that United States production of crude oil for the year reached an all-time high of 2,242,698,000 bbl., exceeding the previous peak of 1948 by 10.6 per cent. As a result of 1951 operations there was a net increase of 1,416,000,000 bbl. in the estimated crude-oil reserves of the country. The oil produced during the year was replaced by new discoveries and an increment of roughly 1.4 billion barrels was added to reserves. The discoveries for the year therefore were 3.659 billion barrels approximately. Before 1951 the peak year was 1937. The following comparisons for the two years are of interest, the units being millions of barrels:

	1937	1951
Total discoveries	3.342	3.659
Production	2.042	2.213
Net addition to reserves	1.300	1.416

Record year.—It is clear that 1951 was an all-time record year for the United States oil industry with respect to total discoveries, production, and net addition to reserves. In fact, it appears to have been a record year for the industry in all respects with the notable exception of profits. It is a record to which geophysicists have made important contributions and an achievement in which they can take

great pride. We may also derive great satisfaction from the realization that this contribution has been made to a vital component of our national economy, and the anxiety of the nation can be somewhat relieved by the fact that the oil industry met its problems so successfully.

Resistivity Departure Charts

(Continued from page 198)

grid of the HD chart is traced. The ordinate axis of the transparent grid and that of the chart are made to coincide, and the transparent paper is moved parallel to these axes until the two points fall simultaneously on the same departure curve. The corresponding ordinates D/S and D/S′ of the two points are read off the HD chart, and from them the desired value of D is obtained. It should be noted that the foregoing procedure gives also R_t/R_m, whereby the mud resistivity R_m can be determined. This value of R_m can then be used in other parts of the same hole (after correction for temperature, if needed) to speed up the determination of D by applying the simplified procedure using only one resistivity graph.

If it is planned to determine the bore diameter in a shale formation for a number of wells of the same area, it will be found convenient to retrace the HD charts on a grid where absolute coordinates, instead of relative ones, are marked: S and R_t are given their known numerical value, and the chart will then represent directly D vs. R_s for any value of R_m.

The foregoing remarks can be made regarding the HD charts.

1. The range of applicability is greater for three-electrode arrangements than for two-electrode arrangements.

2. The range of applicability increases when the formation resistivity increases.

3. The accuracy of the method is poor when the formation resistivity is nearly equal to the mud resistivity. The method fails completely when R_t equals R_m.

4. The accuracy is greater for three-electrode arrangements than for two-electrode ones.

5. The HD curves should be used only in the D/S range shown in Figs. 6 and 7.

Resistivity of Mud-Invaded Formations

Consider a permeable formation, a sand for example, penetrated by a bore hole and partly invaded by the drilling mud. Let R_t and R_w represent the sand resistivity in the non-invaded zone and the resistivity of its interstitial water, respectively. These two quantities are related by the following expression:

$$R_t = F \times R_w$$

where F is a constant called the formation factor: its value is usually independent of the resistivity of the interstitial water. Therefore, if the original interstitial water is entirely replaced by another water, mud filtrate for example, the following relation can be written:

$$R_t = F \times R_m \qquad (1)$$

where R_m and R_t represent the mud filtrate resistivity and the resistivity of the mud-invaded zone, respectively. The mud-filtrate resistivity usually nearly equals the resistivity of the mud itself, although there are exceptions.[8]

Close to the bore hole, the sand concerned is invaded by the mud filtrate. If it is a water sand, the mud filtrate has probably displaced all the original interstitial water over a certain distance from the bore. If the sand contains oil or gas, the displacement is usually only partial. For the sake of simplification, it will be here assumed that full displacement has taken place. In this case, the sand resistivity close to the bore equals R_t. Far from the bore, there is no invasion and the sand resistivity is equal to R_t. Between these two points there is an intermediate zone where

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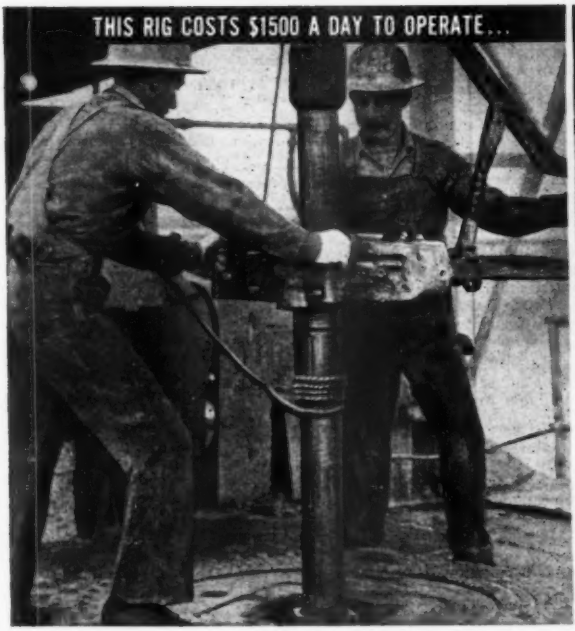

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only part of the interstitial water is displaced.

As far as electrical logging is concerned, it is convenient to simplify the foregoing picture by assuming that there is a uniformly and fully invaded zone Z up to a distance L (see Fig. 8). Beyond this distance, the sand is assumed to be not invaded. The resistivity of zone Z equals R_i, while that of the medium beyond Z equals R_t.

The three media.—In the logging of an invaded formation we have then to consider the three following media:

The mud column: diameter D, resistivity R_m.

The invaded zone: diameter D_i, resistivity R_i.

The formation beyond the invaded zone: resistivity R_t.

The numerical value of the formation factor F of any formation is always greater than unity. It ranges from about 3 for very porous sands to 100 or more for well-cemented beds, and the average value for petroleum reservoirs exceeds 6. Referring to Relation 1 it can be seen that the resistivity of the invaded zone of a permeable bed is always greater than the mud resistivity. Therefore, only cases where R_i is greater than R_m need be considered.

Departure charts.—Departure charts similar to those established for two media (noninvaded formations) can be calculated also for thick formations invaded by mud. A typical example is shown on Fig. 9.

Because so many factors have to be considered in a discussion of the apparent resistivity for mud-invaded formations, it is not possible to represent the data with only one chart as is done for a two-medium distribution. In noninvaded formations only the factors R_t, R_m and S/D control the optimum resistivity R_a. In the case of invaded formations, it is necessary to consider also R_i and D_i/D. Therefore, full representation of the data requires several groups of charts which give R_a/R_m vs. S/D as a function of the following quantities:

Group 1: D_i/D variable, R_i/R_m and R_t/R_m constant.

Group 2: R_i/R_m variable, D_i/D and R_t/R_m constant.

Group 3: R_t/R_m variable, D_i/D and R_i/R_m constant.

If full data are available for any one group, they can be used for establishing any chart belonging to another group: no new calculations are required. Some of these charts, as well as many additional comments on the subject, can be found in the literature.[3,4]

Thin Beds

All the foregoing discussions concern thick beds, i.e., beds whose thickness is several times greater than the maximum electrode spacing considered. They do not apply to thin beds.

A general method for calculating rigorously the peak or low-resistivity values for a bed of finite thickness, and taking into account the effect of the mud, has not been developed as yet. Excellent approximate calculated data are available for two-electrode arrangements.[5] For three-electrode arrangements, data are available at the present time only for beds of infinite resistivity and not invaded by mud. Let T denote the bed thickness and S the electrode spacing. Fig. 10 gives the peak value R_a in terms of the ratio S/T and for several values of T/D, D denoting the hole diameter. The data are accurate (calculated) for spacing lengths smaller than the bed thickness (i.e., for relatively thick beds), but they are only approximate for the longer spacings.

Complete and accurate data for thin beds can be obtained on models, but none are available for publication as this is written.

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4. H. G. Doll, J. C. Legrand, and E. F. Stratton: "True Resistivity Determination from the Electric Log," The Oil and Gas Journal, September 20, 1947.
5. Schlumberger Document No. 3: "Resistivity Departure Curves," 1949.

Digests

(Continued from page 182)

they outline the paleogeography of Tertiary seas, the deeps, shelves, shoals, and bays.

Carbon-14 Measurements On Geologic Samples

J. LAURENCE KULP, Lamont Geological Observatory, Columbia University, Palisades, N. Y.

RECENT results of the natural radiocarbon content of numerous specimens of geologic interest will be presented. These include late Pleistocene glacial history, deep sea sedimentation, and deep ocean circulation. The geological significance of these results will be discussed.

Frequency Distribution of Recent Foraminifera Off California

ORVILLE L. BANDY, University of Southern California, Los Angeles

IN order better to evaluate the ecology of the fossil Foraminifera in the Tertiary rocks of California, groups of bottom samples were selected from off the San Diego, Point Conception, and San Francisco Bay regions. These general groups were arranged in depth profiles and then frequency counts were made which revealed about six depth-temperature assemblages. These assemblages correlate in part with the established zones of Natland but serve to subdivide and to extend such zonation to a depth of about 11,500 ft.

It should be emphasized that many species are fairly widespread according to reports in the literature; however, they are typically most abundant in somewhat restricted zones and with the proper delimitation of many such zones, it should be possible to extrapolate into the past with greater certainty and accuracy.

Vertebrate Paleontology and Continental Stratigraphy in Colombia

R. A. STIRTON, University of California, Berkeley

FIELD work in Colombia, South America, has resulted in the discovery of one of the largest and most complete late Miocene vertebrate faunas.

Representations of late Eocene, early and late Oligocene, and Pleistocene assemblages have also been located. This has disclosed important evidence on the dispersal, evolution, and correlation of Cenozoic vertebrate faunas in South America. Correlation has been made with the continental sequence in Argentina.

Our knowledge is now sufficient to establish stage refinement in our correlation of the continental beds in northern South America and with continued exploration this kind of correlation can be extended throughout the continent. This is possible because mammals evolved rapidly and dispersed widely in a relatively short time. Usually only a few teeth or jaw fragments are required to recognize the age of the beds in which they occur.

Some of our reports including information on thickness of sections, sources of materials, orogenies, nature of deposition and paleoecology are nearing completion. We are now anxious to locate continental and marine tieins to establish, if possible, a trans Caribbean-Gulf Coast correlation.

BOOKS

"JACOBSON'S MAP OF WILLISTON BASIN SHOWING OIL AND GAS FIELDS."

Size 42 by 48 in. Scale, 1 in. = 10 miles; map covers south portions of provinces of Saskatchewan and Manitoba, East Montana, Northeast Wyoming, west portions of North and South Dakota. Map shows: Oil fields in green, gas fields in red, drilling wells with name of operator and dry holes with name of company, elevations, and total depths. Firm also has just produced new sectionalized state maps showing same information of the following states on a scale of 1 in. per 5 miles: East Montana, Wyoming, Utah, Colorado, North Dakota, South Dakota, Nebraska, Kansas, and Oklahoma.

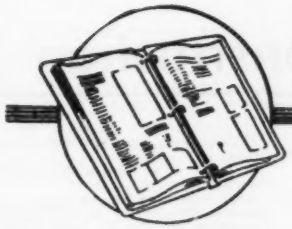
Publisher is E. C. Jacobson Maps; change of office location has been made from 516 Mayo Building to 315 Mayo Building, Tulsa.

TAX-SHELTERED INVESTMENTS. By William J. Casey and J. K. Lasser, published by Business Reports, Inc., 225 West Thirty-Fourth Street, New York City. 138 pp., $12.50.

This loose-leaf volume presents a thoughtful study of how savings and family security are seriously affected by current taxes. In 16 chapters it evaluates as many kinds of investments, varying from tax-exempt bonds through timber and mining. Chapter 12 is devoted to the oil industry. The authors explain fully how the 27½ per cent depletion allowance operates, and present a scholarly and informed resume of the various types of oil investments and their chances of realizing a profit for the investor. Examples are given of how an operating group works; how an oil investment syndicate works; how a proven producer, a royalty investment, and a wildcat operation are affected by taxes. The novice as well as the seasoned investor will profit by a reading of this well-written chapter.

OIL SHALE AND CANNEL COAL. Edited by George Sell. Published by the Institute of Petroleum, Manson House, 26 Portland Place, London. Vol. 2, 830 pp. 63 s.

This book is a report of proceedings of the Second Oil Shale and Cannel Coal Conference, organized by the Institute of Petroleum and held in Glasgow, Scotland, in July 1950. Fifty papers were read and discussed, covering all aspects of oil shale and shale oil—mining, retorting, refining, utilization, and essay.



THE REFINER'S notebook

No. 115

Balanced Disk and Vented Piston Relief Valve

by S. Chesler* and B. W. Jesser†

MENTION has been made of three methods of approach to the problem of relief-valve system design which will be developed in this series. One method involves the use of special types of safety-relief valves known as "back pressure" valves. In the preceding installment of Refiner's Notebook the development of a vented bonnet relief valve was discussed. This was the first attempt to develop a back pressure valve.

From the vented bonnet valve work proceeded to the development of: (a) the balanced disk and piston, and (b) the bellows valve. One form of (a), namely the balanced disk and sealed piston valve was also dealt with in installment No. 114.

Another form of this type (a) of relief valve is shown in Fig. 1 and might be termed the balanced disk and vented piston valve. It is similar to the sealed piston valve except for the construction of the secondary piston. In the closed position there is a close fit between the secondary piston and the guide. However, the piston is recessed so that the moment the valve is opened, a large area is available to vent gases from within the guide. These gases are vented into the bonnet and out the bonnet vent to the atmosphere. The area of the hole in the guide is considerably smaller than the area between the recessed piston and the guide. Therefore, the pressure within the guide, when the valve is in the open position, is reduced to a small fraction of the back pressure.

Furthermore, the ejector effect of the gases passing by the hole in the guide as they leave the valve has a tendency to reduce the pressure within the guide.

Free analysis.—Reference to Fig. 2a indicates that, in the closed position, the vented piston valve performs essentially in the same manner as the sealed piston valve. Forces D operate over the entire top area of the disk, but forces E in the opposite direction counteract a portion of these forces. Since the areas as so balanced that D — E = C, there is no net effect resulting from back-pressure forces acting on the disk when the valve is in the closed position. Performance tests have substantially confirmed this and the disk neither lifted off its seat prematurely nor was held closed above set pressure when superimposed back pressure was applied. Fig 2b shows the valve in the open position with the area within the guide vented and the forces D and E reduced to a small fraction of forces C.

Capacity and blowdown. — Capacity tests with steam were very good. The rated capacity was maintained to the critical and then with increasing back pressure the capacity gradually fell off following a path slightly below the theoretical curve. As for blowdown, the release of pressure above the seat might lead one to believe that a long blowdown would result. However, this was not the case and, although the blowdown under high back pressure was above normal requirements, it was satisfactory.

*Piping engineer and †head of piping analytical section, M. W. Kellogg Co. Portion of paper presented at Toronto meeting of A. S. M. E.

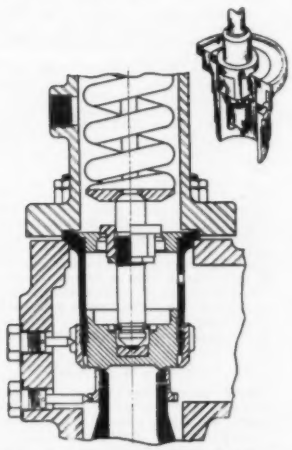


Fig. 1—Balanced disk and vented piston relief valve. (Courtesy, Crosby Valve & Gage Co.)

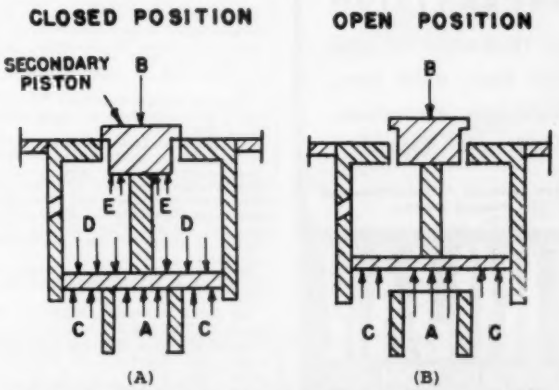


Fig. 2—Action of forces for balanced disk and vented piston valve, (vented bonnet) in closed and open positions.

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Pipe-Line Construction

FOLLOWING is a tabulation of pipe-line projects which are planned or under construction. Included are crude-oil, products, and natural-gas lines. This list is compiled from surveys made by The Oil and Gas Journal.

Crude-Oil Pipe Lines

Cities Service Pipe Line Co.—64 miles, 18-in., proposed, Sour Lake, Tex., to Lake Charles, La.

Continental Pipe Line Co.—105 miles, 8-in., authorized, Rincon to northwest of Sullivan City on to Port Isabel, Tex. Completion date 1952.

217 miles, 12-in., authorized, Wichita Falls, Tex., to Ponca City, Okla. Completion date 1952.

Gulf Refining Co.—80 miles, 24-in., proposed, Midland to Colorado City, Tex.

Humble Pipe Line Co.—4, 6, 8, 12-in., proposed, Upton and Reagan counties, Texas.

Interstate Oil Pipe Line Co.—33 miles, 20-in., authorized, Bunkie to Melville, La. Completion date 10-52.

68 miles, 16-in., authorized, Raceland to Anchorage, La. Completion date 10-52.

18 miles, 12-in., authorized, LaRose to Raceland, La. Completion date 10-52.

47 miles, 16-in., authorized, Sunset to Anchorage, La. Completion date 7-52.

Mid-Continent Pipe Line Co.—23 miles, 4-2-in., under way, Elmore City to Velma, Okla. C. P. Carter Const. Co. Gus Bowman, spreadman at Duncan, Okla. Completion date 3-1-52.

Ohio Oil Co.—117 miles, 22-in., under way, Sheridan, Ind., to Lima, Ohio. R. A. Conyes, contractor.

Pan American Pipe Line Co.—27 miles, 26-in., Genoa to Texas City, Tex. Completion date 12-52.

40 miles, 14-in., Arden Station in Irion County to Eldorado Station in Schleicher County, Texas. 6-52.

Platte Pipe Line Co.—1,075 miles, 16, 20-in., under way, Worland, Wyo., to Wood River, Ill. Completion date 1952.

573 miles, 16-20-in., under way, Worland, Wyo., to Holdredge, Neb. R. H. Fulton & Co., contractor. A. A. Carrigan, spreadman at Scotts Bluff, Neb.

142 miles, 20-in., under way, Holdredge, Neb., to Kansas State Line. Fulton & Brodie, contractor, J. T. Brodie, spreadman.

Section 7. 274 miles, 20-in., Missouri River to Salisbury, Mo., and Section 8, Salisbury to Mississippi River, under way. O. R. Burden Construction Co. Al Perry, spreadman at Carrolton, Mo.; river crossing field office, Hartford, Ill., Dick Jernigan, spreadman.

Progress Pacific Pipe Line Co.—900 miles, 20-in., proposed, Permian basin, West Texas to California.

Rancho Pipe Line System.—455 miles, 24-in., authorized, McCamey to Houston, Tex. Completion date late 1952. (Joint project with Sinclair Pipe Line Co., Pan American Pipe Line Co., Tidewater Pipe Line Co., Nantucket Pipe Line Co., Phillips Pipe Line Co., and Ashland Pipe Line Co. with Shell Pipe Line Corp. handling construction and operation.

267 miles, contracted, McCamey to Cedar Valley near Austin, Tex. Anderson Bros. Corp.

188 miles, contracted, Austin to Houston. Houston Contracting Co.

Roosevelt Oil & Refining Corp.—22 miles, 4 and 6-in., authorized, St. Helens to Norwich, Mich.

Service Pipe Line Co.—28 miles, 20-in., looping, authorized; Drumright, Okla., to Humboldt, Kans. G. G. Griffis Const. Co., contractor. E. G. Grisham, spreadman at Drumright.

30 miles, 10-in., proposed, Lea County, New Mexico.

30 miles, 6-in., Knox and Haskell counties, Texas.

29 miles, 4, 6, 8-in., proposed, Natrona County, Wyoming.

Shell Pipe Line Co.—42 miles, 8-in., authorized, Hallettsville to La Grange, Tex. Completion date 7-1-52.

66 miles, 8-in., authorized, Gohlke to La Grange, Tex. Company crews. Completion date 1952.

Sinclair Pipe Line Co.—674 miles, 22, 24-in., under way, Drumright, Okla., to East Chicago, Ind. Completion date 1952.

Section 1—150 miles, 24-in., under way, Drumright-Cushing, Okla., area, to Humboldt, Kans. O. R. Burden Construction Co.

(Spread 1) 60 miles, 24-in., under way, Caney to Humboldt, Kans. A. B. Haynes, supt., at Chanute, Kans.

(Spread 2) 90 miles, 24-in., under way, Cushing, Okla., to Caney, Kans. Floyd Lewis spreadman at Hominy, Okla.

184 miles, 24-in., under way, Humboldt, Kans., to Missouri. R. H. Fulton & Co., contractor, M. L. Boyd and Jerry Nash, spreadmen.

Skelly Oil Co.—38 miles, 8-in., under way, Lyons to Burrton, Kans. Rumsey Bros., contractor. Completion date 1-52.

Sterling Pipe Line System.—53 miles, 12-in., authorized, Sterling, Colo., to connection with Platte Pipe Line at Gurley, Neb. (includes 20 miles, 10-in., main line; 35 miles, 6-in., branch lines.) Joint venture comprising Toronto Pipe Line Co., Shell Pipe Line Corp., and Texas Pipe Line Co.

Sun Pipe Line Co.—99 miles, 4, 6, 8-in., proposed, Scurry County, Tex.

Texas Pipe Line Co.—319 miles, 22, 12, 10-in., Louisiana Gulf Coast to Port Arthur, Tex., including 220 miles, 22-in., Houma, La., to Port Arthur, Tex.; 31 miles, 12¾-in., Houma to Cocodrie, La. Houston Contracting Corp. Completion date in summer 1952.

175 miles, 16-in., under way, Corsicana to East Houston. Smith Contracting Corp. Frank Craig, spreadman at Teague, Tex. Completion early summer.

319 miles, 22, 12, 10-in., under way, Louisiana Gulf Coast to Port Arthur, Tex. Houston Contracting Co.

220 miles, 22-in., under way, Houma, La., to Port Arthur, Tex. Houston Contracting Co.

67 miles, 22-in., under way, Holmwood, La., west to Port Arthur, Tex. Houston Contracting Co., E. C. Norris, superintendent at Lake Charles, La.

67 miles, 22-in., under way, Holmwood east to Gueydan, La., and from Morgan City east to Houma. Houston Contracting. W. H. Hayes, superintendent, at Jennings, La.

86 miles, 22-in., under way, Gueydan east to Morgan City, La. Houston Contracting. F. A. Silar, superintendent, at Abbeville, La.

65 miles, 6, 8, 10-in., under way, and 30 miles, 12-in., Houma, La., south through Terrebonne Bay vicinity. Houston Contracting. H. L. Leake, superintendent, at Houma.

West Texas Gulf Pipe Line Co.—471 miles, 26-in., contracted, Colorado City to Wortham, Tex., Wortham to Sour Lake, Tex., 24-in. Completion date 10-52.

114 miles, 20-in., contracted, Wortham to Longview, Tex. Completion date 10-52.

44 miles, 26-in., under way, Glenrose, Tex., area. Anderson Brothers, contractor.

Products Pipe Lines

Bell Oil & Gas Co.—150 miles, 6-in., planned, Ardmore to Drumright, Okla. (Includes 114 miles, 8-in., 32 miles, 6-in.)

Buckeye Pipe Line Co.—370 miles, 8, 12, 16-in., authorized, Linden, N. J., via Allentown, Pa., to Auburn, Syracuse, Waterloo, and Rochester, N. Y. (Sections divided as follows: 75 miles, 16-in., 218 miles, 12-in., 77 miles, 8-in.). Start 1952, completion of 16-in., 1952, balance 1953.

Coastal Products Pipe Line Co.—260 miles, 20-in., proposed, Houston to Baton Rouge.

Ohio Oil Co.—255 miles, 8, 10-in., proposed, East St. Louis, Ill., to Indianapolis.

24 miles, 8-in., authorized, East St. Louis to Wood River, Ill.

Phillips Oil Co.—28 miles, 12-in., authorized. Sweeny to Freeport, Tex. Completion date 3-52.

Phillips Pipe Line Co.—42 miles, 10-in., under way, Green Ridge to Villa Ridge, Mo. Mid-States Const. Co. T. H. Edmonds, superintendent at Sedalia, Mo.

34 miles, 8-in., under way, Kankakee, Ill., to Dyer, Ind. Somerville Const. Co. O. P. Hiner, spreadman at Kankakee. Completion date 3-15-52.

68 miles, 12¾-in., under way. Osawatomie westward to Wichita, Kans. Brown Lite Co. R. E. Carriker, spreadman at Osawatomie, Kans.

40 miles, 10-in., through Monteau, Cole, Osage, and Gasconade counties, Missouri, Trojan Const. Co. E. L. Maggard, spreadman at Linn, Mo.

Under way, Paloa, Kans.-Harrisonville, Mo. Smith Contracting Corp.

74 miles, 8-in., under way, looping from Decatur, Ill., to East Chicago, Ind. Somerville Const. Co., contractor.

137 miles, 10-in., authorized, looping from Paola, Kans., to East St. Louis, Ill.

Pioneer Pipe Line Co.—(Continental Pipe Line Co. and Sinclair Pipe Line Co.). 310 miles, 8-in., proposed, Sinclair, Wyo., to Salt Lake City, Utah.

Progress Pacific Pipe Line Co.—900 miles, 10-in., proposed, California to West Texas.

Salt Lake Pipe Line Co.—Proposed, Pasco, Wash., to Puget Sound.

Shell Oil Co.—565 miles, 8-14-in., planned, Wood River via East Chicago to Detroit; 35 miles, 14-in. Completion date summer of 1952.

Sinclair Pipe Line Co.—10-in., Houston to Baton Rouge; 16-in., Kalamazoo to Detroit; 20-in., Marcus Hook to Bayonne, N. J.; East Chicago to South Bend, Ind.

Standard Oil Co. (Ind.).—316 miles, 12-in., proposed, Sugar Creek refinery to Dubuque, Iowa.

122 miles, 8-in., under way, Neodesha, Kans., to Belton, Mo. Bills & Troth Construction Co., Carl Bills, superintendent, at Armory Building, Neodesha. Completion date 1952.

Standard Oil Co. (Ohio).—17 miles, 6-in., authorized, Toledo to West Toledo, Ohio.

Susquehanna Pipe Line Co.—123 miles, 6, 8-in., proposed, Fostoria to Randolph, Ohio.

United States Pipe Line Co.—1,000 miles, proposed, Gulf Coast via Memphis, Nashville, Tenn., Lexington, and Paducah, Ky., to Cincinnati, Ohio.

Natural-Gas Pipe Lines

Algonquin Gas Transmission Co.—140 miles, 24-26-in., under way, New Jersey to Connecticut River near New Haven. Williams Brothers, contractor. Completion date 8-1-52.

Allied Gas Co.—24 miles, 6⅝-in., proposed, McLean to Champaign County, Illinois.

Arkansas-Missouri Power Co.—140 miles, proposed, Arkansas and Missouri.

Associated Natural Gas Co.—88 miles, authorized, Missouri.

Carolina Natural Gas Corp.—185 miles, 2-12-in., proposed, lateral lines off Transcontinental in North and South Carolina.

Cities Service Gas Co.—179 miles, 4-30-in., gathering system in vicinity of Ulysses, Kans. Vaughn & Taylor Const. Co., Inc. D. D. Vaughn, spreadman, Ulysses.

21 miles, 26-in., proposed, Franklin and Anderson counties, Kansas.

15 miles, 20-in., Craig County, Oklahoma, to Lawrence County, Missouri.

Coast Counties Gas & Electric Co.—40 miles, 3, 4, and 8-in., planned. Coast and Valley region, California.

Colorado Interstate Gas Co.—250 miles, 20-in., under way, Kit Carson, Colo., to Amarillo, Tex. R. H. Fulton & Co., contractor. Jerry Nash, spreadman at Lamar, Colo.

16 miles, 4-in., Pueblo County to Fowler, Colo.

Commonwealth Natural Gas Corp.—537 miles, 20-in., proposed, West Bend, Ky., to Norfolk, Va.

Cumberland & Allegheny Gas Co.—46 miles, 10-in., authorized, Mountain Lake Park, Md., to Preston County, West Virginia.

Dow Chemical Co.—70 miles, various sizes, Midland, Saginaw, and Bay City, Mich. Mahoney Contracting Co., contractor. Ralph Bucher, spreadman at Midland.

East Tennessee Natural Gas Co.—172 miles, 22-in., authorized, Greenbrier to Oak Ridge, Tenn.

100 miles, 16-in., proposed, Knoxville to Kingsport, Tenn.

El Paso Natural Gas Co.—133 miles, 30-in., proposed, looping along main line in Texas, New Mexico, Arizona.

36 miles, 24-in., proposed, looping from Kingman to Franconia, Ariz.

Equitable Gas Co.—17 miles, 16-in., under way, near Pittsburgh, H. L. Gentry Const. Co., contractor. Lavern Curtis, spreadman at Sewickley, Pa.

Georgia Gas Co.—32 miles, 4½-in., proposed, Bogart to Gainesville, Ga.

Glacier Gas Co.—285 miles, 20-in., proposed, Kalispell, Mont., to Spokane, Wash.

120 miles, 16-in., proposed, Spokane to Hanford, Wash.

91 miles, 8⅝-in., proposed, Spokane to Lewiston, Idaho.

130 miles, 12¾-in., proposed, Spokane to International boundary at Trail, British Columbia.

Grand Valley Pipe Line Co.—105 miles, 8-10-in., planned, Piceance Creek field to Rifle on to Grand Junction, Colo.

Gulf Michigan Transmission Corp.—650 miles, 30-in., proposed, Perryville, La., across Arkansas, Missouri, and Illinois, to terminus near St. John, Ind.

Home Gas Co.—32 miles, proposed, Chemung and Broome counties, New York.

17 miles, 12-in., proposed, loops from Hancock to Sanford, N. Y.

Iowa-Illinois Gas & Electric Co.—41 miles,

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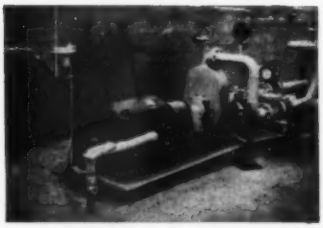
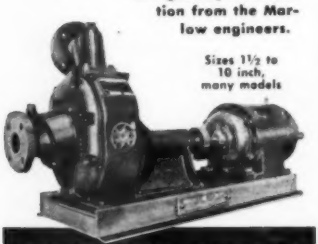


This 3 inch Marlow Self-Priming Centrifugal Model 322 HEL-7 is installed in the pumping station of Cities Service Refining Corporation's big Lake Charles Refinery, Louisiana, which opened early in 1944.

The pump is used in intermittent operation for stripping pipe lines and storage tanks and for removing sludge from pump pit. It's an efficient, virtually maintenance-free installation . . . the kind that helps cut refining headaches.

For many years Marlows have handled oil reliably in many types of installations. A Marlow primes and reprimes automatically. It won't vapor lock and it operates quietly and smoothly because of its free-flow design. Construction is heavier than necessary assuring long life and the utmost in dependability.

Oil men everywhere know the Marlow pump for its ability to solve pumping problems. Your inquiry will get expert attention from the Marlow engineers.



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Manufacturers of the World's Largest, Most Dependable Line of Self-Priming Centrifugal, Diaphragm and Plunger Pumps

10-in., authorized, Washington County to Cedar Rapids, Iowa.

¾ to 6-in., under way, Davenport, Iowa, and Moline, Ill. C. E. Wilson Const. Co.

Kansas-Nebraska Natural Gas Co., Inc.—179 miles, proposed, Kansas and Nebraska.

40 miles, 6-in., under way. Albion to Norfolk, Neb. Jayhawk Const. Co., Inc., contractor; F. A. Faler, spreadman at Albion.

30 miles, 6-in., under way, Albion to Neligh, Neb. Jayhawk Const. Co., Inc. F. A. Faler, spreadman at Albion.

60 miles, 8, 10, 12-in., under way, Grand Island to Albion, Neb.

65 miles, 2-8-in., authorized, Big Springs field to Ogallala, Neb., and to Ovid, Colo.

39 miles, 4 and 6-in., planned, Neligh to O'Neill, Neb. 54 miles, 4 and 6-in., planned, Neligh to Hartington, Neb. (extension). Completion date 1952.

Kansas Power & Light Co.—27 miles, 20-in., authorized. Pratt, Kans., to Calista compressor station.

Lake Shore Pipe Line Co.—45 miles, 10¾-in., authorized, northwesterly from T.G.T. system near Meadville, Pa., to Ashtabula, Ohio.

Lone Star Gas Co.—100 miles, proposed, storage fields to the Dallas-Fort Worth area.

Manufacturers Gas Light & Heat Co.—40 miles, proposed, Allegheny, Washington, and Beaver counties, Pennsylvania.

Michigan Gas Storage Co.—93 miles, 16, 22, 24-in., under way, Laingsburg to near Pontiac and Mount Clemens, Mich. (Includes 17 miles of lateral lines.) Mahoney Contractor. Completion date 6-52.

30 miles, 26-in., authorized, looping between Laingsburg and Mount Pleasant Junction, Mich.

Michigan Gas Utilities Co.—77 miles, under way, Sturgis, Hillsdale, and Coldwater, Mich. (22.7 miles, Marshall south to Coldwater; 20 miles, Coldwater easterly to Hillsdale; 22.5 miles, Hillsdale to Sturgis, 11 miles, Hillsdale to Jonesville.) Somerville Const., contractor. Jim Godwin at Coldwater.

MidSouth Gas Co.—240 miles, proposed, Greene, Poinsett, Crittenden, St. Francis, Lee, Phillips, Monroe, Woodruff, and Cross counties, Arkansas.

Mississippi River Fuel Corp.—98 miles, 16- and 18-in., authorized, feeder line from Lincoln Parish, Louisiana, to Waskom field, Harrison County, Texas.

40 miles, 18-in., authorized, Dubach to Perryville, La.

Missouri Central Gas Co.—25 miles, 6-in., contracted, Moberly to Macon, Mo. L. R. Young Const. Co.

Montana Power Co.—52 miles, 16-in., authorized, Canada-Montana border to Cut Bank, Mont.

National Utilities Co. of Michigan.—76.7 miles, 20-in., proposed, South Central Michigan. (22 miles from near Marshall south to Coldwater; 20 miles east to Hillsdale; 22 miles southwest to Sturgis; 5 miles from Hillsdale to Jonesville and 8 miles west to Union City.)

Nevada Natural Gas Pipe Line Co.—114 miles, 10-in., proposed, Topock, Ariz., to Las Vegas, Nev.

New River Gas Co.—50 miles, planned, Summers to Monroe counties, West Virginia to Narrows and Dublin, W. Va.

New York State Natural Gas Corp.—104 miles, 14, 16, 20-in., authorized, looping on Westmoreland, Armstrong, and Tioga counties, Pennsylvania. (Includes 17 miles, 16-in., in Potter County, Pennsylvania, and 21 miles 14-in., replacement in Line No. 507, New York.)

New York Natural Gas Co.—21 miles, Columbiana and Stark counties, Ohio.

Niagara Mohawk Power Corp.—55 miles, 10-in., Fulton to Watertown, N. Y.; Williams-Austin Co., contractor, Howard Bauer, supt. Completion date 9-52.

Northeastern Gas Transmission Co.—221 miles, 20-24-in., authorized, New Hampshire, Massachusetts, and Connecticut.

Northeastern Gas Co.—411 miles, proposed, New England towns.

Northern Natural Gas Co.—580 miles, proposed, Kansas, Texas, Oklahoma, and Nebraska loops.

210 miles, 26-in., proposed, five loops in Texas-Oklahoma area, two in Kansas, and two in Nebraska.

Northern Indiana Fuel & Light Co.—33 miles, 8-in., proposed, Edgerton to Auburn, Ind.

Northwest Natural Gas Co.—750 miles, planned, Washington, Oregon, and Idaho.

373 miles, 24-in., proposed, Eastport, Idaho, to Monroe, Wash.

79 miles, 18-in., proposed, Monroe to International boundary near Lynden, Wash.

29 miles, 22-in., proposed, Monroe to near Seattle, Wash.

164 miles, 20-in., proposed, Seattle to Portland, Ore.

Ohio Fuel Gas Co.—31 miles, 20-in. authorized, Licking County to Richland County, Ohio.

25 miles, 20-in., under way, Xenia, Ohio Sheehan Pipe Line Const. Co. Earl Williams, spreadman at Xenia.

22 miles, 16-in., authorized, Dayton, Troy, Piqua, and Sidney, Ohio.

23 miles, 16-20-in., authorized, Wellington to Elyria, Ohio; 16 miles, 20-in., authorized, Benton Station to Crawford Station. 18 miles, 20-in., Crawford Station to near Columbus. 16 miles, 16-in., authorized, Berlin to Sandusky, Ohio.

74 miles, 3 to 20-in., authorized, Hocking, Knox, and Ashland counties, Ohio.

47 miles, 20-in., authorized, Benton Township, Hocking County, to Columbus, Ohio.

61 miles, authorized, northern and southwestern Ohio.

Oklahoma Natural Gas Co.—14 miles, 8⅝-in., under way, Shamrock to Cushing, Okla.; 21 miles, 24-in., under way, Depew to Kellyville, Okla. 9 miles, 12¾-in., Stroud to Depew, Okla. 26 miles, 12-in., under way, Ringwood to Enid, Okla. Trojan Const. Co. Charles Tillotson, spreadman at Enid.

Pacific Gas & Electric Co.—44 miles, 8-in. under way, Salinas to King City, Calif. W. A. Tyler, contractor. Completion date 1952.

141 miles, 34-in., proposed, parallel sections along Topock-Milpitas line.

10 miles, 10-12-in., authorized, Monterey to Fort Ord to Castroville; 12 miles, 16-in., Napa Wye to Shellville; 6 miles, 12-in., Cotati to Santa Rosa, Calif.

Pacific Northwest Pipeline Corp.—Alberta fields through to Pincher Creek, Spokane, Hanford, Vancouver, and Portland.

Panhandle Eastern Pipe Line Co.—70 miles, 24-26-in., under way, looping from Sneed, Tex., to Emporia, Kans.

174 miles, 30 and 26-in., contracted. Tuscola, Ill., eastward—looping present system; R. A. Conyes, contractor. 44 miles, 26-in., Edgerton, Mich.; Anderson Bros.; 22 miles, 30-in., looping in Tuscola, Ill.; 45 miles, 30-in., looping in Montezuma, Ind.; 63 miles, 30-in., looping in Zionsville, Ind.

Pennsylvanian Gas Co.—52 miles, 12-in., between Warren and Erie, Pa. Section 1—27 miles, under way and contracted by Harford Bros. Section 2—25 miles.

Peoples Natural Gas Co.—25 miles, proposed, Cambria and Blair counties, Pennsylvania.

Phillips Petroleum Co.—118 miles, 3-22-in., under way, Sherman and Hansford counties, Texas, gas-gathering system; Vaughn & Taylor Construction Co., Inc., Dumas, Tex., J. F. Crawford, spreadman at Texhoma, Okla.

Prairie Pipe Lines, Ltd.—Windsor, Ont., to Montreal, Que., Canada.

Prince George's Gas Corp.—20 miles, 22-in., authorized, between Chillum and Rockville, Md.

Public Service Co. of Colorado.—95 miles, proposed, Douglas Creek and other gas fields to Grand Junction, Colo., area.

Public Service Co. of North Carolina.—33 miles, 10-in., authorized, Burlington to Chapel Hill, N. C., completion date 3-1-52; 16 miles, 8-in., authorized, Chapel Hill to Raleigh, N. C., completion date 7-1-52; 29 miles, 4-in., authorized, Statesville to Kanapolis, N. C., completion date 7-1-52; 83 miles, 8-in., authorized, Kings Mountain to Asheville, N. C., completion date 3-1-53.

Rockland Light & Power Co.—22 miles, 8-in., proposed, Orangetown to Tompkins Cove, N. Y.

Southern California Gas Co.—35 miles, planned, Antelope Valley, California.

Southern California Gas Co. and Southern Counties Gas Co. of California.—45 miles, 30 in., proposed, looping on line from Arizona border to Los Angeles.

81 miles, 30-in., proposed, Whitewater to Desert Center, Calif.

Southern Natural Gas Co.—21 miles, 24-in., authorized, Perryville Station La., to Boeuf River.

14 miles, 24-in., authorized, Onward Station, Miss., to Big Sunflower River.

14 miles, 14-in., authorized, Perryville Station, La., to Wilhite Gate.

375 miles, 24-in., planned, Gwinville, Miss., to Atlanta, Ga.

169 miles, proposed loops, Ouachita Parish, Louisiana, to Augusta, Ga.; 20 miles in Ouachita Parish, 33 miles in Ouachita and West Carroll parishes; 7 miles, Sharkey County, Mississippi; and 108 miles, 14-in., Bass Junction to Augusta, Ga.

Southern Union Gas Co.—21 miles, 20-in., authorized, Albuquerque, N. M.

27 miles, 10-in., authorized, Lea and Eddy counties, New Mexico.

30 miles, 12-20-in., contracted, San Juan County, New Mexico. R. H. Fulton & Co.

Southwest Gas Corp., Ltd.—26 miles, proposed, from P.G.&E. line to Victorville, Calif.

Sunray Oil Corp.—133 miles, 3-30-in., under way, system for Snyder gasoline plant. Vaughn & Taylor Construction Co., contractor. D. D. Vaughn, spreadman.

Tennessee Gas Transmission Co.—591 miles, 24-30-in., proposed, looping along present system (consisting of 323 miles of 30-in.; 167 miles of 26-in.; 101 miles of 24-in.)

420 miles, 30-in., Texas, Louisiana, Arkansas, Mississippi, Tennessee, and Kentucky.

101 miles, 26-in., Kentucky and Ohio.

304 miles, 24-in., proposed, Mercer, Pa., to Utica, N. Y.

250 miles, miscellaneous laterals.

Texas Eastern Transmission Corp.—791 miles, 30-in., under way, Kosciusko, Miss., to Connellsville, Pa.

Section 1 and 2, 163 miles, 30-in., under way, Kosciusko, Miss., to Florence, Ala. Williams Bros.-Davis Co.

Section 3, 76 miles, 30-in., Florence, Ala., to Columbia, Tenn. Eastern Pipe Line Contractors.

Section 4, 73 miles, 30-in., under way, Columbia, Tenn., to Cumberland River. H. B. Zachry Co. A. Vaughn, superintendent at Lebanon, Tenn.

Section 5, 79 miles, 30-in., under way, Cumberland River to Columbia, Ky. Oman Const. Co. William Smith, superintendent and Floyd Hudnell, spreadman at Columbia, Ky.

Section 6, 82 miles, 30-in., under way, Columbia, Ky., to Boonesboro, Ky. N. A. Saigh Co.

Section 7, 100 miles, 30-in., under way, Kentucky River to Ohio River, northeastern Kentucky. Mahoney Const. Co.

Section 8, 77 miles, 30-in., under way, Portsmouth to Amesville, Ohio. Anderson Bros. Corp.

Section 9, 74 miles, 30-in., under way, Amesville to Ohio-West Virginia river crossing. Anderson Bros. Corp.

Section 10, 66 miles, 30-in., under way, Ohio River to Connellsville, Pa. Anderson Bros Corp.

50 miles, 30-in., under way, Ohio River to Vanceburg, Ky. Trojan Construction Co., Inc., contractor. Charles Tillotson, spreadman at Morehead, Ky.

Texas Gas Transmission Corp.—408 miles, 26-in., proposed, looping from Bastrop to Hardinsburg, Ky.

223 miles, 26-in., proposed, Bastrop, La., to Covington, Tenn.

47 miles, 26-in., proposed, northeastward from Covington.

49 miles, 26-in., proposed, northeastward from Kenton, Tenn.

45 miles, 26-in., proposed, northeastward from Calvert City, Ky.

25 miles, 26-in. proposed, northeastward from Slaughters, Ky.

19 miles, 26-in., proposed, southwestward from Jeffersontown, Ky.

35 miles, 12-in., authorized, Slaughters, Ky., to Evansville, Ind.

180 miles, 26-in., authorized, Acadia Parish to connection with existing facilities in Morehouse Parish.

195 miles, 26-in., proposed, Gulf Coast region to southwestern Louisiana.

560 miles, 26-in., proposed, Louisiana and Kentucky.

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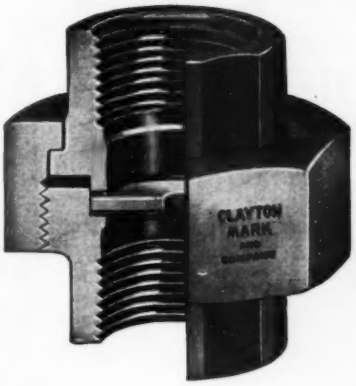

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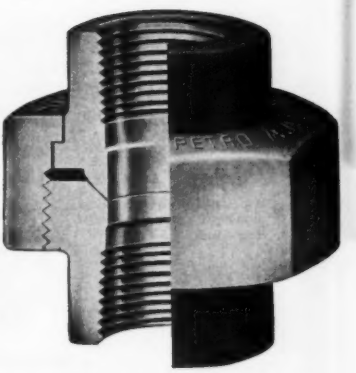

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Texas-Ohio Gas Co.—1,350 miles, 30-in., proposed, Hidalgo County, Texas, through Arkansas, Mississippi, Tennessee, and Kentucky on to Spencer, W. Va. Completion date 6-30-53.

Union Oil Co. of California.—40 miles, 8-10-in., planned, San Joaquin Valley and Los Angeles basin.

United Fuel Gas Co.—22 miles, 20-in., under way, Lanham to Broad Run, W. Va. H. L. Gentry Construction Co., contractor. Frank Morris, spreadman at Charleston, W. Va.

United Gas Pipe Line Corp.—315 miles, 24-30-in., under way, Agua Dulce to near Goodrich, Tex. Oklahoma Contracting Co., contractor. Panama Shiflett, spreadman, El Campo, Tex.; Ray Law, spreadman, Victoria, Tex.

510 miles, 20 to 30-in., under way, Agua Dulce, Tex., to Monroe, La. River Const. Corp., contractor.

Spread 1, 51 miles, 30-in., from Pearl River north and south of Jackson, Miss. Red Tatom, superintendent at Jackson.

Spread 2, 45 miles, 30-in., McComb to Pearl River south of Jackson. Merle Tatom, superintendent at Hazelhurst.

Spread 3, 30 miles, 30-in., Kosciusko south toward Jackson. Jimmy Reed, superintendent at Kosciusko.

Spread 4, 29 miles, 12-in., Lafayette to Jeanerette, La. Roy Earnhart, spreadman at Jeanerette.

Spread 6 and 7, 97 miles, 20-24-26-in., under way, Houston to Dupont's Sabine River Works, Orange, Tex. Barney Hall, superintendent at Port Arthur.

Spread 6, 20 miles, 20-in., under way, Orange to Port Neches, Tex. (This spread to move on to Trinity River and work toward Houston.) Banty Traweek, spreadman.

Spread 7, 20-26-in., under way, Port Neches to Fannett, Tex. (This spread will continue on to Trinity River.) Borger Red McMenamy, spreadman.

124 miles, Sterlington compressor station, near Monroe to Jackson, Miss.

23 miles, 8-12-16-in., South Louisiana facilities.

53 miles, 24-in., authorized, Texas.

50 miles, 16-in., authorized, Baldwin County, Alabama, southeasterly to Escambia County, Florida.

36 miles, proposed, offshore from Ingleside to near Refugio, Tex.

All contracted by River Const. Corp., a joint venture including Oklahoma Contracting Co.; J. Ray McDermott & Co., Inc., and Morrison-Knudson. Inspection by Brown & Root, Inc.

Virginia Natural Gas Co.—153 miles, Buckingham to Richmond and Portsmouth, Va.

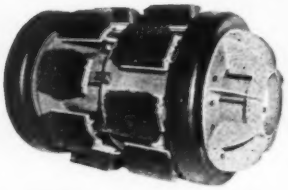
Western Kentucky Gas Co.—2 to 4-in., under way, additions to present system; Modern Welding Co., Inc., contractor.

Western Pipe Lines.—1,200 miles, 22-in., planned, southern Alberta to Duluth, Minn.

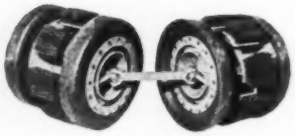
West Texas Gas Co.—27 miles, 10-in., authorized, Lubbock to Abernathy, Tex.

THE PIG WITH THE POKE — CLEANS PIPE LINES

MORE CUBIC FEET PER DAY... THROUGH NATURAL GAS LINES CLEANED by WILLIAMSON PIGS

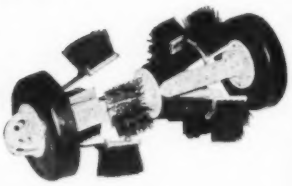


GP-2 16"-30"
Similar design 10" to 14" sizes. Will traverse all standard pipe-line gate valves and field bends of approx. 12 ft. radius.



GP-3 18"-30"
Similar design 10" to 16" sizes. Will traverse long-radius welding ells up to 90° lengths. Also through port and many conventional gate valves.

WC-12 6"-14"
Will traverse all standard pipe-line gate valves and field bends.



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Canadian Equipment Sales & Service Co., Ltd., Edmonton, Calgary, Toronto, Canada

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Foreign Crude-Oil Pipe Lines—Planned and Under Way

Alberta-Vancouver Oil Pipe Line Co.—(Brokaw, Dixon, McKee).—972 miles, 16-in., proposed, Edmonton via Pincher Creek, Alta., Idaho and Washington states to Vancouver, B. C.

Cia. de Petroleo Ganso Azul, Ltd.—48 miles, 4-in., planned, Ganso Azul field to Pucalpa on upper Ucayali River, Peru.

Condor.—90 miles, 12-in., under way, Genoa to Rho, near Milan, Italy. Soc. Ital. Condotte Acqua Montubi, contractor. Completion date 7-31-52.

Creole Petroleum Corp.—143 miles, 26-in., authorized, Ule (State of Zulia) to Amuay (State of Falcon). Completion date March 1953.

25 miles, 34-in., authorized, Lagunillas to La Salina (State of Zulia). Completion date April 1953.

Direccion General de Yacimientos Petroliferos Fiscales.—409 miles, under way, Plaza Huincul to Bahia Blanca, Argentina.

Iraq Government.—135 miles, 12-in., proposed, from Iraq Petroleum Co. at Balja to Baghdad, Iraq. Construction 1952, M. W. Kellogg, contractor.

Iraq Petroleum Co., Ltd.—556 miles, 30-32-in., under way, Kirkuk, Iraq, to Banias, Syria, 1952; Bechtel-Kirkuk, contractor.

72 miles, 12¾-in., Zubair to Fao. Arabian Bechtel Co., contractor.

Kuwait Oil Co., Ltd.—10 miles, 20-in., authorized, third transit line Burgan-Ahmadi. Completion date 2-52. 6 miles, 30-in., authorized, sixth gravity loading line, Ahmadi-Mina al Ahmadi. Completion date 6-52. 5 miles, 16-20-in., authorized, Burgan field—oil collecting line. 2-52.

Middle East Pipelines, Ltd.—800 miles, 34-35-in., planned, Iran to a Levantine port.

Petroleos Mexicanos.—145 miles, 12-in., considered, 18 de Marzo field via Reynosa to Monterrey, Mexico.

100 miles, planned, Isthmus of Tehuantepec, Jose Colomo to El Plan field, Minatitlan.

Spitz & O'Berine.—264 miles, 24-in., under way, Capetown to Tarrytown, South Africa. J. C. Spitzexplari, spreadman at Capetown.

Texas Petroleum Co.—60 miles, 4-6-in., under way, Pto, Nino to La Dorada.

Trans-Mountain Oil Pipe Line Co.—715 miles, proposed, Edmonton, Alta., to Vancouver, B. C. Canadian Bechtel, Ltd., engineers.

Foreign Products Pipe Lines—Planned and Under Way

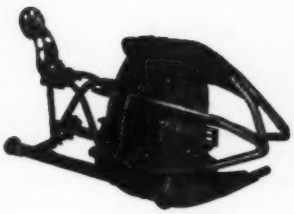
Colombia Ministry of Petroleum.—90 miles, 6-in., planned, Puerto Berrio to La Dorada, Colombia.

113 miles, 6-in., contracted, Puerto Berrio to Acededo near Medellin, Colombia. Carolina Construction Co.

75 miles, 4-in., planned, Buena Ventura to Cali, Colombia.

Empresa de Ferrocarriles Ecuatorianos.—50 miles, 6-in., contracted, Guayaquil to

CROSE
INTERNAL LINEUP
CLAMPS



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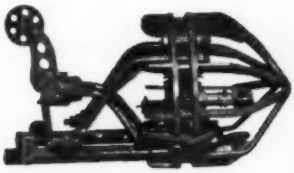
Crose Internal Lineup Clamps are available in manual, electric and hydraulic models for pipe sizes ranging from 12″ to 36″. Crose Internal Lineup Clamps have been proven in world-wide field operations.



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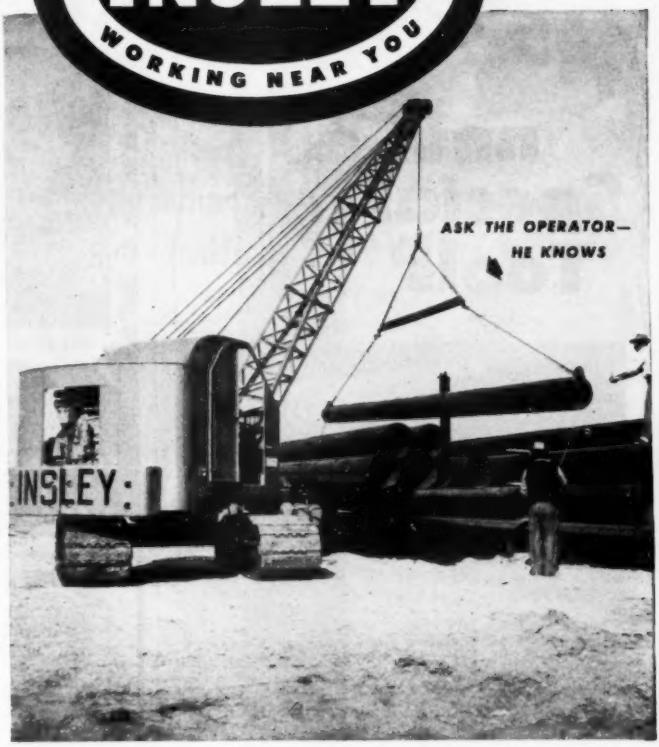

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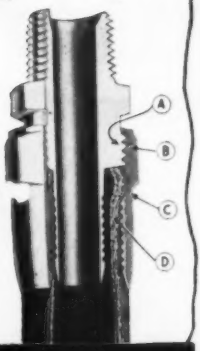

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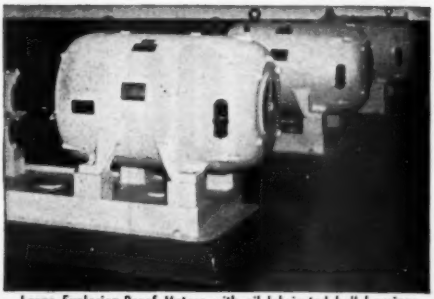

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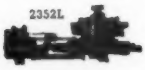
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Palmira, Ecuador. J. A. Jones, contractor; C.R.C. Engineering Co., engineers.

Estrada de Ferro Santos a Jundiai.—32 miles, 18-in., under way, Santos to Sao Paulo, Brazil ((fuel oil line); Techint, contractor. Completion date 12-51.

Governments of Southern Rhodesia and Portuguese East Africa.—200 miles, considered, Beria, Portuguese Mozambique to Umtali, Southern Rhodesia.

Imperial Oil Co., Ltd.—230 miles, 10-12-in., under way, Sarnia via London, Hamilton to Toronto, Ont., Canada. Comstock-Midwestern, Ltd., contractor. Completion date July 1952.

Petrocogno (Sub. Cie. Financiere Belge des Petroles, S.A.).—225 miles, considered, Ango-Ango to Leopoldville, Belgian Congo.

Petroleos Mexicanos.—155 miles, 10-in., under way, Minatitlan to Salina Cruz, Mexico.

Societe des Transports Petroliers par Pipe Line.—140 miles, 10-in., under way, Le Havre to Paris, Fance. Entrepose, contractor. Completion date 1952.

State of Cundinamarca, Colombia.—120 miles, 6-in., Puerto Salgar to Bogota, Colombia; Williams Brothers Co.; David Louthen, manager, Bogota.

Trans-Northern Pipe Line Co.—400 miles, proposed, Hamilton, Ont., to Toronto, Ont., to Montreal, Que., Canada.

Foreign Natural-Gas Pipe Lines—Planned and Under Way

Azienda Generale Italiana Petroli.—110 miles, 12-14-16-in., planned, Cortemaggiore to Genoa.

145 miles, 14-16-in., under way, Cortemaggorie to Torino. Completion date 1951.

Canadian Delhi Oil Co. (Subsidiary Delhi Oil Co.).—2,132 miles, proposed, Alberta, Toronto, Montreal.

Direccion General del Gas del Estado.—310 miles, 8-in., under way, Plaza Huincul to Neuquen, Argentina, to the vicinity of General Conesa, Argentina.

Northwest Natural Gas Co.—950 miles, 24-in., planned, Alberta fields to Vancouver, B. C., Seattle, Wash., and Portland, Ore.

Petroleos Mexicanos.—205 miles, 16-in., considered, Monterrey to Torreon, Mexico.

260 miles, 20-in., under way, Monterrey to Tampico and Poza Rica, Mexico.

Petroleos Mexicanos, Mexican Gas Co., and Industrial Gas Co.—600 miles, planned, Reynosa, Tamaulipas, to Tampico-Poza Rica, Mexico.

Trans-Canada Pipe Lines, Ltd.—Proposed, Alberta to Toronto to Montreal.

Venezuela Atlantic Transmission Corp.—195 miles, 10-12-16-in., under way, El Placer near Las Mercedes, State of Guarico to Caracas, La Guaria, Maracay, and Valencia. Contracted by Williams Brothers, de Venezuela, S.A., B. E. Barnes, manager.

Westcoast Transmission Co., Ltd.—1,110 miles, 24-in., planned, Dawson Creek, B. C., through Pine Pass and Fraser River Valley to Kamloops, Princeton, and Vancouver to Portland. Ford, Bacon & Davis, engineers.

280 miles, 20-in., planned, Pincher Creek to Montana on to Spokane, Wash. Ford, Bacon & Davis, engineers.

Western Pipe Lines.—1,033 miles, 24-in., proposed, from southern Alberta, eastward across the Canadian prairies, serving principal towns and cities along the route to a point near the International boundary.

Gas Facilities Leased

WASHINGTON. — Mississippi Gas Co., Meridian, Miss., has been authorized by the Federal Power Commission to lease and operate natural-gas transmission facilities in Mississippi to be built and owned by North Central Natural Gas District, a political subdivision of the State of Mississippi.

The facilities include a 99-mile pipe line from a connection with Southern Natural Gas Co.'s main line in Winston County to Bruce in Calhoun County.

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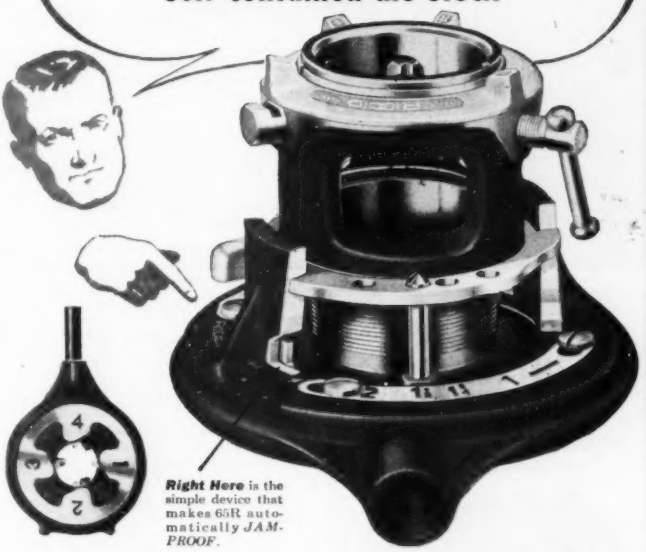
Really streamlined pipe threading with this RIDGID self-contained die stock



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PIPE LINES

Form Clarified

Use of revised PAD-26LP to get line pipe explained

WASHINGTON. — The Petroleum Administration for Defense has issued a new question-and-answer explanation of points most frequently raised regarding use of the revised Form PAD-26LP.

This form is used to secure priorities assistance in the purchase of line pipe for use in small construction and production operations and for MRO.

Q. Gas-transmission and oil transportation companies usually carry a few joints of line pipe at regular intervals along their line for use in emergency repairs. Should they report such stocks of line pipe on Form PAD-26LP?

A. Yes.

Q. Some operators use a single lot of line pipe a number of times each year. How should an operator report the use of such line pipe?

A. In such cases the operator should report only a single use.

Q. Must an operator whose total quarterly requirement of line pipe for MRO, production operations, and small construction is $5,000 or more get priorities assistance only through a Form PAD-26LP, or does he have some other avenue open to him?

A. In general Form PAD-26LP must be filed. If, however, an operator has an emergency MRO requirement, he may file two copies of the delivery orders with PAD in accordance with Section 4(e) of NPA Order M-46.

Q. Suppose an operator has received authorization to obtain line pipe during the third quarter of 1952 by filing the delivery orders with PAD. Must he then continue to file delivery orders for the whole third quarter, or should he file a Form PAD-26LP?

A. Again, as in 6, Form PAD-26LP must be filed. However, the filing of the form is necessary only if the operator requires line pipe in addition to that already authorized.

Q. If an operator finds it necessary to replace a worn-out line (an MRO operation), must he replace it in kind—that is, with the same size pipe?

A. Generally speaking, the replacement of a worn-out line should be in kind. PAD has no desire, however, to force replacement of obsolete material in kind. The agency may, then, permit an exception to the rule if the operator will present sufficient evidence of the necessity for a change. The operator can, of course, avoid the whole question of replacement in kind by filing a Form PAD-26 rather than a PAD-26LP.

Q. Has PAD made any provision for issuing advance authorizations for purchases of line pipe?

A. Yes. The revised Form PAD-26LP permits an operator to ask for an authorization to get line pipe in the next succeeding quarter. PAD may be able to approve a part of the operators' requests for one advance quarter.

Arkansas-Missouri Plans New Gas-Transmission Lines

BLYTHEVILLE, Ark. — Arkansas-Missouri Power Co. is planning construction of two natural-gas-transmission lines totaling about 140 miles in southern Missouri and northern Arkansas.

Both of the lines, estimated along with distribution systems to cost about $4,090,835, would receive gas from Texas Eastern Transmission Corp.'s system. The first would extend southwest from a connection with Texas Eastern in Clay County, Arkansas, to Rector, Ark. The other would be laid south from Campbell, Mo., to near Evadale, Ark.

Arkansas-Missouri said it has a contract with Texas Eastern for a supply of about 6,308,000 cu. ft. of gas per day for the proposed system. The new lines would serve 13 communities in Arkansas and 5 in Missouri. The company has filed with the Federal Power Commission for approval of the project.

Imports Sought

Pacific Northwest files revamped plan with FPC

WASHINGTON.—Pacific Northwest Pipeline Corp., Houston, has filed with the Federal Power Commission for approval of its plan for an international exchange of natural gas between the United States and Canada. *(The Oil and Gas Journal, February 11, page 72).*

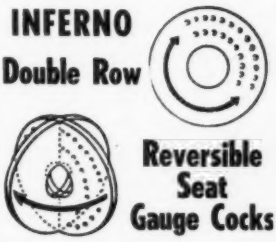
Under the company's new proposal (a revision of an application filed with the commission in June 1950) approximately 250,000,000 cu. ft. of gas per day would be imported from fields in Alberta to the Pacific Northwest. In return the company proposes to export an equivalent amount to eastern Canada which it would purchase from Panhandle Eastern Pipe Line Co.

Construction. — The new plan involves construction by Pacific Northwest of about 830 miles of pipe lines, mostly in Washington, at an estimated cost of $58,425,000. The transmission system would include 550 miles of main transmission line, 175 miles of lateral lines, and three compressor stations with a total of 14,080 hp. The facilities would serve the principal populated areas in the Pacific Northwest, including Spokane, Seattle, and Tacoma, Wash., and Portland, Ore.

Gas from Alberta would be delivered at the northern boundary of Stevens County, Washington, by Prairie Transmission Lines, Ltd., a subsidiary of Pacific Northwest. About 25,000,000 cu. ft. of this gas would be returned to Prairie at the northern boundary of Whatcom County, Washington, for delivery to Vancouver, B. C.

Gas purchased from Panhandle

INFERNO
Double Row



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would be delivered at the international boundry near River Rouge, Mich., for redelivery to Canadian Natural Gas Pipe Lines, Ltd., for transmission into Ontario and Quebec.

Original plan. — Pacific Northwest's original proposal involved construction of a 2,175-mile system from Texas to Washington and from Alberta to the same area. This program would have cost more than $174,186,602.

Hearings on the proposal will be held April 8. The company's application has been consolidated with three others proposing imports from Alberta to serve market areas in the Pacific Northwest. Other companies seeking permission to import are Northwest Natural Gas Co., Westcoast Transmission Co., Inc., and Glacier Gas Co.

Pipe-Line Briefs

Socony-Vacuum Oil Co., Inc., central pipe-lines division, is preparing to kick off construction of a 16-mile, 10-in. loop to increase capacity of its crude trunk line from Chase to Valley Center, Kans. The new loop will add 15,000 bbl. daily to capacity of the trunk section, which connects with other carriers at both Chase and Valley Center.

Service Pipe Line Co. will start surveys and obtain right-of-way soon for a second crude pipe line from Saunders pool in Lea County, New Mexico, to a connection with the company's West Texas system. The new 26-mile, 10-in. line, recently approved by the Petroleum Administration for Defense, will move oil east via Denton pool to Wasson station.

The Federal Power Commission has O.K.'d Mississippi Valley Gas Co.'s proposed acquisition and operation of natural-gas pipe-line facilities of Mississippi Power & Light Co. These include about 1,199 miles of 3-in. equivalent lines and leased systems totaling about 242 more miles of 3-in. Basic purchase price is $11,128,151, subject to closing adjustments. The lines are located in Adams, Attala, Bolivar, Carrol, Coahoma, DeSoto, Grenada, Hinds, Holmes, Humphries, Leake, Leflore, Montgomery, Rankin, Sharkey, Sunflower, Tate, Tunica, Washington, and Yazoo counties. Both firms are headquartered in Jackson, Miss.

Ohio Fuel Gas Co. has filed plans with the Federal Power Commission calling for construction of 33 miles of 20-in. natural-gas line to replace about 42 miles of existing 8 and 10-in. lines in Crawford, Wyandot, and Seneca counties, Ohio. Cost of facilities which the company said are required to protect market service next winter, is estimated at $1,400,000.

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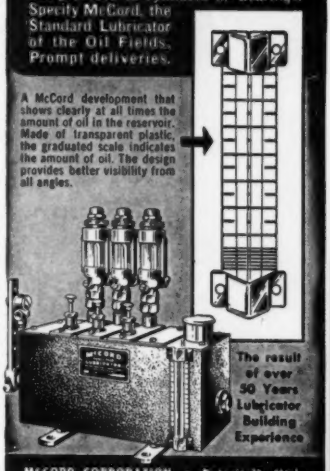

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REFINING

New Refinery

Sunray breaks ground for 28,000-bbl. Corpus plant

CORPUS CHRISTI. — Sunray Oil Corp. has broken ground and started construction of its new 28,000-bbl. refinery 7 miles west of here.

T. C. Bodley, project expediter for the company, said preliminary excavation work, construction of a concrete base for a workman's headquarters, and erection of protective fencing is already under way.

Foundation-construction equipment is already on the job, and construction equipment and materials for preliminary phases of the operation are being moved in by Lumus Co., contractors. Completion is scheduled in late summer of 1953.

Facilities.—New facilities will include a 28,000-bbl. U.O.P. fluid catalytic cracking unit and a Lumus crude-distillation unit and treating plant. The new refinery will be operated in conjunction with crude-oil-gathering facilities of Sunray Coastal Pipe Line Co. and Sunray's deep-water barge and tanker docks at the Port of Corpus Christi.

Temporary field superintendent for the Lumus organization is Bart Hughes, who has established an office at the plant site.

Informal ground-breaking ceremonies were held, with Floyd L. Martin, vice president for refining, and Paul E. Taliaferro, vice president, both of Tulsa, present for the occasion.

Site for the new refinery was acquired from Southern Minerals Corp., of Corpus Christi.

Treasury Take From Four Federal Oil Taxes Climb

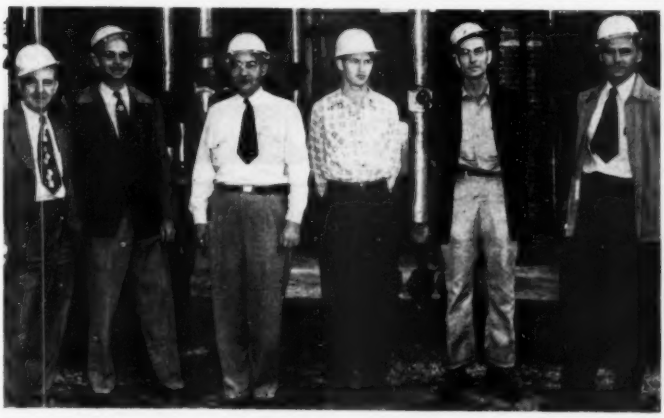
WASHINGTON. — With an assist from the increased rate on gasoline and the new tax on diesel oil, Treasury collections from the four federal oil taxes approximated $74,000,000 in January, it is reported by the Bureau of Internal Revenue.

The gasoline tax at the 2-cent rate, plus collections of an additional ½ cent on floor stocks, brought in $60,259,598 compared with $43,699,573 in January 1951, the bureau disclosed. The new diesel-oil tax brought in $980,876 for the first full month of application.

The bureau also received $10,312,935 from lubricating oils against $10,835,432 in January 1951, and $2,685,835 from pipe-line transportation against $1,919,112.

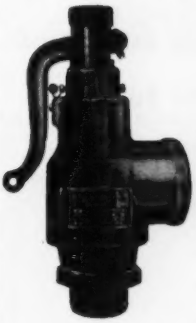
Socony-Vacuum Continues Extensive Building Program

NEW YORK.—Socony-Vacuum Oil Co., Inc., will spend $35,000,000 this year on further refinery expansion in this country and in Europe. Of this total, $27,000,000 will be spent for three Thermofor catalytic reforming



SAFETY SUPERVISORS.—The Waterloo, Ark., refinery of Berry Asphalt Co. recently completed 3½ years of operation without a lost-time accident. A few of the spark plugs of Berry's safety program (left to right) are Clyde Davis, Employers Mutual of Warsaw, engineer; Carl Berger, superintendent of Waterloo refinery; A. T. Van Pelt, vice president of Berry Asphalt; Morgan Moore, safety-committee chairman; Ira Weems, production superintendent; and Roger N. Smith, vice president in charge of production and pipe lines.

2" HIGH CAPACITY SAFETY POP VALVES



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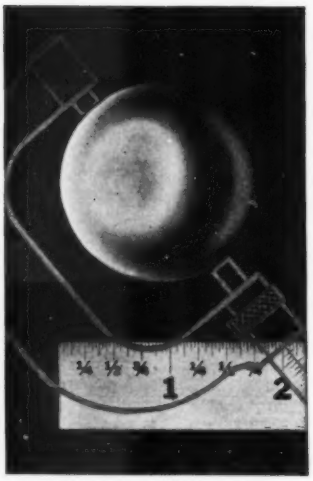

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units to be constructed at the company's Augusta, Kans., refinery and at the Beaumont, Tex., and Torrance, Calif., plants of Magnolia Petroleum Co. and General Petroleum Corp. Also included in the budget for new reforming facilities is a catalyst plant at Paulsboro, N. J.

The company's 15 domestic refineries processed a daily average of 520,000 bbl. of crude during 1951, up 10 per cent from 1950. In Western Europe, the company's five refineries ran an average of 90,000 bbl. per day, an increase of 36 per cent over 1950 operations.

In its construction program, the company and affiliates have completed construction of nine Air-lift TCC units here and in France, and four additional units are under construction in the United States, Germany, and Italy.

Brown Says Flying Safety Not Impaired by TEL Order

WASHINGTON.—The setting of a minimum level of tetraethyl lead content for civil-aviation gasoline does not impair the flying safety of well-managed air lines.

This was Bruce K. Brown's answer to a suggestion made by Representative Beckworth, chairman of a special House commerce subcommittee, that the order setting the minimum level be suspended if supplies will permit such action.

Brown, deputy administrator of the Petroleum Administration for Defense, urged that the committee look at the facts and not let its view of these facts be obscured by "special pleaders and I-told-you-so testimony.""

The facts, Brown said, will show that much of the civilian avgas consumed by airlines during and since World War II has contained 4 cc. or more of TEL.

Refining Briefs

British-American Oil Co., Ltd., recently awarded an extra day's pay to each of the 118 employes of the company's 7,200-bbl. refinery at Calgary, Alta., in recognition of their completion of an entire year of operation without a lost-time injury. It was the third such award in the last 6 years at the refinery. An article in a recent issue of The Oil and Gas Journal incorrectly credited employes of the 10,000-bbl. Imperial Oil, Ltd., refinery at Calgary with the achievement.

The Petroleum Administration for Defense revealed this week that the use of butylenes in alkylation units during the past year increased 25,000 bbl. daily to a level of 80,000 bbl. per day. Use of refinery butylenes for the manufacture of synthetic rubber jumped 2,100 bbl. daily to 14,800 bbl. per day.

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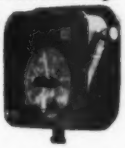

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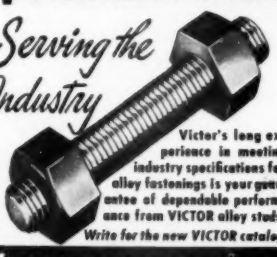

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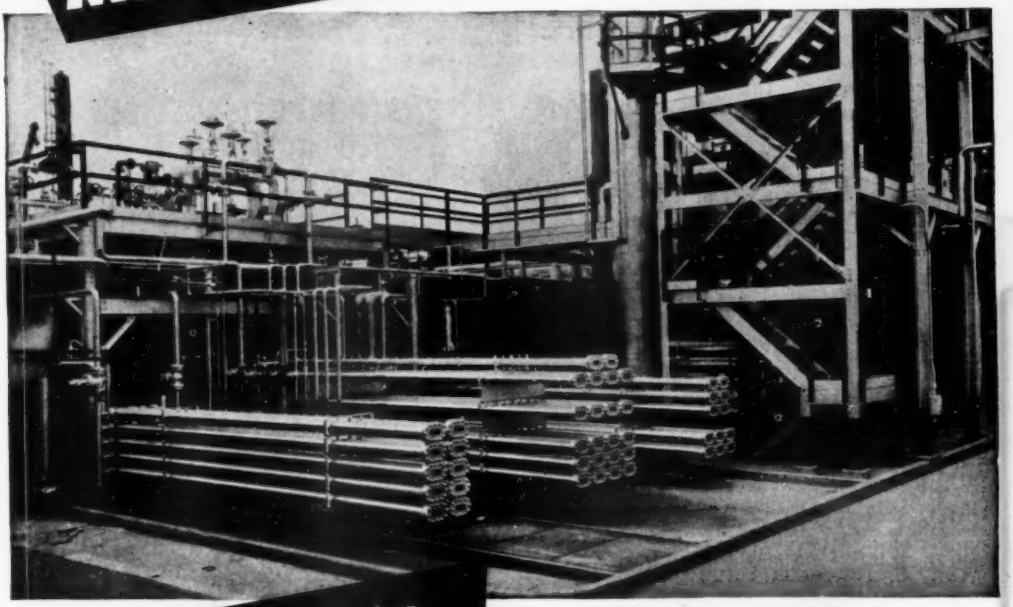

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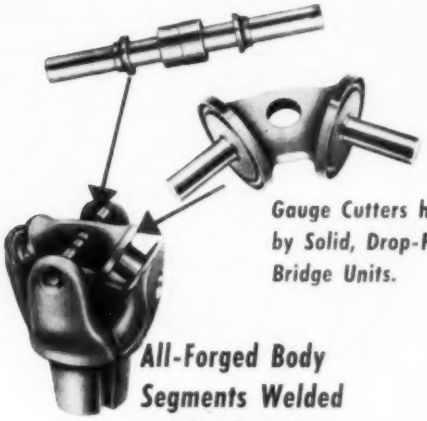

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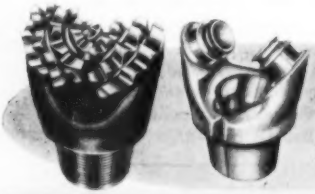

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Number of Active Rigs Breaks Decline Trend

A substantial increase in the number of operating rotary rigs in the United States and western Canada was reported during the week ended March 17. It boosted the total to 2,892, the greatest number since early February, and may mark the turning point that ends the normal seasonal decline in drilling activity which has been experienced since the first of the year. Most notable increases in drilling were in the North and West Texas - New Mexico and Oklahoma areas. Decreases were reported only in the Illinois - Eastern and Pacific Coast areas.

ACTIVE ROTARY RIGS*
(United States and Western Canada)

Area—	Week ended 3-17-52	Change week ended 3-10-52	Change week ended 3-19-51
Gulf Coast	609	+ 5	+ 95
N. & W. Tex.-N. M.	1,055	+ 28	+ 258
Ark.-N. La.-E. Tex.	155	+ 1	+ 14
Oklahoma	341	— 30	+ 53
Kansas-S. Nebraska	150	0	+ 2
Illinois-Eastern	75	— 9	+ 36
Rocky Mountains	170	+ 6	+ 64
Pacific Coast	158	—10	+ 24
Total United States	2,713	+ 51	+546
Western Canada	179	+ 2	+ 68
Total	2,892	+ 53	+614

*Courtesy Hughes Tool Co. Trends in drilling activity in the United States and the Rocky Mountains and western Canada areas are shown on pages 254 and 255.

Falcon Seaboard Drilling Co., Tulsa and Houston, has a Phillips Petroleum Co. contract for another 10,500-ft. well, 1 Acadian, in the Crowley field, Acadia Parish, coastal Louisiana. Location is in 14-10s-1e.

Loffland Brothers Co., Tulsa, has taken on two additional deep-drilling contracts in coastal Louisiana. One is for a 13,000-ft. offshore well to be drilled for Pure Oil Co. in Block 32, Eugene Island area, St. Mary Parish. It will be Pure's 4-A State. The other will be a 9,800-ft. well in the South Mallet field, Acadia Parish, to be drilled for Bates & Cornell at 1 Sloane, in 23-6s-1e.

Crescent Drilling Co., Inc., Monroe, La., has a well-deepening job in the Monroe gas field, Ouachita Parish, northeastern Louisiana. The well, Southern Carbon Co. 1 E. N. Fouke, 22-19n-5e, is one completed last October at a depth of 5,301 ft. It will be deepened to the Smackover lime, expected below 9,000 ft. Contract for a new Gas Rock test, 1-C La Delta, which Southern Carbon Co. has projected for the same field, has gone to **Stovall Drilling Co., Inc.,** also of Monroe. Location is in 33-20n-5e.

Simpson and Kee Form New Contracting Firm

Clyde Simpson and Francis Kee, formerly vice president and assistant superintendent, respectively, of **Thomas P. Pike Drilling Co.,** Los Angeles, have entered the drilling business on their own. They will operate as the **Kee & Simpson Drilling Co.** with offices in the Ohio Oil Building, Los Angeles. Their first contract is with Sunray Oil Corp. for a wildcat test, 36-13 Westlake Farms, in 13-22s-19e, Tulare Lake area, Kings County, California.

Pep Acquires New Rig

Pep Drilling Co., Mount Vernon, Ill., has acquired a new rotary rig. This will make two rigs it will operate in the Illinois basin area. Pursie E. Pipes is owner of the company.

Crow Drilling Co., Shreveport, has the contract for another deep test which Union Oil Co. of California is starting in the Lake Bruin area, in Tensas Parish, Louisiana. This latest operation is 2 Weatherly & Anderson, in 39-12n-12e, which is about 1¼ miles northeast of the first, abandoned as dry at 8,818 ft. The new contract is for 9,500 ft.

Meredith, Clegg & Hunt, Houston, will drill another 12,000-ft. well for The Texas Co. in the East Mud Lake field, Cameron Parish, southwestern Louisiana. It is 1 Miami Corp.-Mud Lake, C SE SE 13-14s-11w.

Woolf & McGee, Shreveport, have contracted with Union Producing Co. for a deep test to be drilled in the abandoned Richland gas field in Richland Parish, northeastern Louisiana. Contract is for 9,200 ft., which should carry the hole to the Cotton Valley formation. Location is for 1-A Earle, in 30-17n-6e.

Tuley & Carter Drilling Co., Evansville, Ind., will drill for Ohio Oil Co. at a new wildcat location in the Cook area, Cheyenne County, Nebraska. The test is 1 Cook, SW SW SW 24-15n-48w.

Nuckolls - Bell Drilling Co., Oklahoma City, has a contract with Vickers Petroleum Co. for a 5,300-ft. test to be drilled at a wildcat location 5

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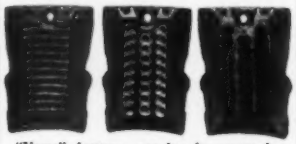

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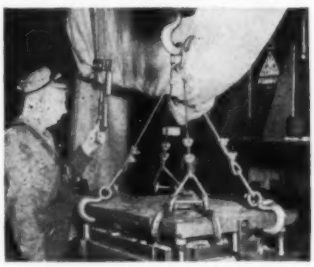

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miles west of Perry, Noble County, Oklahoma. Location is for 1 Freeze, NW NW SE 10-21n-2w. Objective is the Wilcox sand.

R. W. Rine Drilling Co., Wichita, has a rig working for Sunray Oil Corp. on a rank wildcat, 1 Harper, in southeastern Clark County, southwestern Kansas. Location is in the C SE SE 21-34-21.

Thompson Drilling Co., Cushing, Okla., has moved a rig to a location a half mile southeast of the small Northeast Goodnight pool in Payne County, Oklahoma, where it has a contract with Davidor & Davidor of Oklahoma City for a 5,000-ft. Wilcox sand test. The test will be drilled as 1 Scott. Spot is in the NE SW NE 17-17n-2e. **N. V. Duncan Drilling Co.,** Oklahoma City, has a contract with the same operators for a 6,100-ft. Wilcox test located 18 miles to the southwest in Logan County. The latter test, 1 Harned, is 5 miles south of Guthrie in the NE SE SE 4-15n-2w.

Randall Morton Drilling Co., Tulsa, is a partner with Ryan Oil Co. in the drilling of a wildcat test, 1 Brendle, in the Roulette Creek area, southeastern Cleveland County, Oklahoma. Location, in the SW SW NE 11-8n-1e, is 2 miles northeast of production. Hole is projected to the Hunton around 6,350 ft. Morton's tools are being used.

Lohmann & Johnson Drilling Co., Casper, is drilling for Skiles Oil Corp. and associates at a wildcat location, 1 Warner, SW SW NW 3-23n-61w, in Goshen County, Wyoming.

El Dorado Drilling Co., El Dorado, Ark., has contracted for two additional wells to be drilled in Union County, Arkansas, fields. One is Creslenn Oil Co. 5-A Hadley, 3-18s-13w, a 3,500-ft. well at Urbana. The other is E. G. Bradshaw 1 Goodwin, 26-17s-16w, a 2,750-ft. well in the El Dorado South field.

Iraq Drilling Co., Tyler, Tex., is drilling for E. A. Ellison at a wildcat location 1½ miles southwest of Bullard, Cherokee County, East Texas. Location is for 1 Matt Williams in the A. Ferguson Survey.

Carl Brooks, Oil City, La., is the contractor on Magnolia Petroleum Co.'s newest well in the Smackover field, Union County, Arkansas. It is 4 Monroe Smith, contracted for 2,750 ft.

Nowery Drilling Co., Shreveport, contracting for Stanolind Oil & Gas Co., is starting a 6,500-ft. Rodessa test at a wildcat location 2¾ miles northeast of the Fort Lynn field, northwest of Fort Lynn, Miller County, Arkansas. Location is at 1 Kochtitsky, in 9-18s-27w.

Delta Gulf Drilling Co., Tyler, Tex., is starting another deep well for Sun Oil Co. in the Chacahoula field, Lafourche Parish, coastal Louisiana. Newest operation is 5 Lyric, in 66-15s-15e, projected to 12,500 ft.

Anschutz Drilling Co., Wichita, is contractor on a new wildcat test which Pure Oil Co. has projected in Weld County, Colorado. The test is 1 State, C NW NW 12-5n-62w.

L. & H. Drilling Co., Baton Rouge, La., is drilling for Stanolind Oil & Gas Co. at 1-B Baist, 75-9s-10e, a newly started operation in the Bayou Blue field, Iberia Parish, southern Louisiana. Contract is for 7,100 ft.

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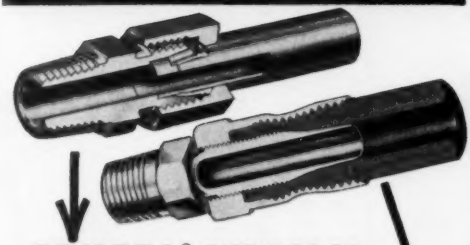

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NATURAL GAS

OPS Urged to Hear Protest On Woodlawn Price in Texas

WASHINGTON.—Rep. Wright Patman of Texas urged the Office of Price Stabilization last week to move a scheduled hearing to Marshall, Tex., on a protest against the ceiling price set for gas from Woodlawn field, Harrison County, Texas.

The action reportedly was taken on the behalf of royalty owners in the field. A formal protest has been filed by Stanolind Oil & Gas Co. and Continental Oil Co. against an order by OPS fixing a ceiling of 10 cents per M.c.f. at the well head for gas produced by the companies for sale to Mississippi River Fuel Corp.

Stanolind and Conoco are seeking a 12 cent per M.c.f. price measured on the Texas pressure base of 14.65 psia. at the well head. The 2-cent increase has already been turned down by OPS twice, the first time August 22, the second in September when the companies appealed *(The Oil and Gas Journal, September 13, 1951, page 152)*.

Stanolind and Conoco contend that large investments in equipment needed to develop large reserves in the field justify a rise in price, and that negotiations with Mississippi River Fuel for the 12-cent rate were completed before the base period though no formal contract had not been entered into at that time.

Texas' December Production Totals 436,000,000 M.c.f.

AUSTIN.—Production of natural gas in Texas totaled almost 436 billion cubic feet in December, according to the Texas Railroad Commission.

This was about 24 billion cubic feet more than the November output and more than 15 per cent higher than production in December 1950. Marketed production reached 367 billion cubic feet, 22 per cent above that marketed a year earlier and about 40 billion cubic feet more than the November figure.

Transmission lines took 63 per cent of the total production, almost 275 billion cubic feet. About 169 billion cubic feet was shipped out of the state, and the remaining 106 billion consumed in Texas. Volumes taken by transmission lines were about 22 billion cubic feet higher than in November and up 27 per cent over the take in December 1950.

Other classes of gas disposition are shown in the accompanying table.

Texas Tax Case Postponed

AUSTIN.—The court test of Texas' natural-gas gathering tax has been postponed until April 7.

The case, originally scheduled to be heard March 17, was delayed by agreement of state and gas-company attorneys because Judge Jack Roberts of the 112th District Court currently is trying a West Texas water-district dispute.

Attorneys have agreed to try two of the 49 cases, those involving Panhandle Eastern Pipe Line Co. and Michigan-Wisconsin Pipe Line Co. These two cover all points of alleged unconstitutionality of the tax.

Natural Gasoline

Permit Asked for Propane, Butane Storage in Texas

AUSTIN.—Freestone Underground Storage Corp. is seeking approval of the Texas Railroad Commission to store L.P.G. underground in Butler salt dome, Freestone County, Texas.

J. A. Farrar, spokesman for the corporation, told Commission Examiner Charles Slack that two wells would be used, one for butane and the other for propane. They would be located on about 11 acres of fee land about 20 miles east of Fairfield, Tex.

The proposed project involves washing out a cavity of about 1,500,000-gal. capacity in each well. Applicant said a salt-water lake has been built to handle about 15,000,000 gal. of brine.

Farrar said one well, already drilled, reached cap rock at 358 ft. and entered salt at 365 ft. Casing was set at 450 ft. and cemented to the surface, and 2½-in. upset tubing was run to total depth at 800 ft.

ULTIMATE DISPOSITION OF ALL GAS PRODUCED IN TEXAS IN DECEMBER
(Source: Texas Railroad Commission)

	M.c.f.	Per cent of total	Per cent of increase over Dec. 1950
Extraction loss—plants*	14,490,222	3.32	16.86
Plant fuel and lease use	32,455,266	7.45	7.48
Gas lift	15,266,874	3.50	19.68
Pressure maintenance and repress	25,093,110	5.76	—13.78
Transmission lines	274,853,634	63.04	27.18
Cycled	43,754,408	10.04	—10.49
Carbon black	26,036,664	5.97	— 3.84
Vented	4,022,759	.92	74.36
Grand total	435,972,937		15.09
Net total for market	367,125,419		22.03

*Extraction loss is shrinkage in gas volume due to removal of liquefiable hydrocarbons.

Four L.P.G.A. Meetings Scheduled in Next Month

CHICAGO.—Sectional meetings of the Liquefied Petroleum Gas Association will be held thick and fast the remainder of this month and through April.

The 3-day Southeastern District convention and trade show opened today in Jacksonville, Fla., at the George Washington Hotel. Featured speaker is Sen. Karl E. Mundt of South Dakota.

Others on the program are Willard F. Rockwell, chairman of the board of Rockwell Manufacturing Co.; Mark Anton, president of Suburban Propane Gas Corp.; John W. Oyler, assistant to the director of the Petroleum Administration for Defense; L. V. Johnson, director of Southern Technical Institute; Howard D. White, L.P.G.A. executive vice president; M. A. Ennis, employe-training director of the National Committee for LP-Gas Promotion; and Elmer Wheeler.

The annual meeting of the New England District has been scheduled for March 26 at the Bradford Hotel in Boston. Plans for the program have not been announced.

Speakers for the Central States convention and trade show March 31-April 1 at the Broadview Hotel in Wichita include Ralph Carney, nationally prominent speaker on salesmanship, Ennis, White, and a representative of Harper-Wyman Co., Chicago.

The Northwestern States meeting is set for April 25-26 at the Olympic Hotel in Seattle.

Stanolind Pushing Plans For New North Cowden Unit

ODESSA, Tex.—Stanolind Oil & Gas Co. has instructed Girdler Corp., Louisville, Ky., to complete plans and purchase of materials for a new sulfur-recovery unit at North Cowden natural-gasoline plant 15 miles northwest of here.

The plant, operated by Stanolind for a group of owners, has been recovering propane, butane, and natural gasoline from casing-head gas produced in North Cowden field since early in 1950. The sulfur-recovery unit will be completed early in 1953.

This is the second such unit announced recently by Stanolind. A similar unit will be built at Slaughter gasoline plant near Sundown, Tex.

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DIAMOND ROLLER CHAINS

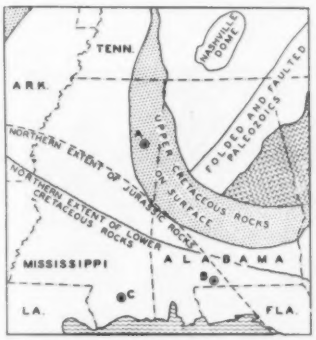
Future Provinces in the Deep South

ALABAMA and Mississippi might be divided into three possible future petroleum provinces: (1) the shallow, unmetamorphosed pre-Mesozoic rocks of the northern portions of these states, (2) the deep, updip wedgeouts of Jurassic and Lower Cretaceous rocks lying beneath a mantle of Upper Cretaceous and younger rocks (see sketch map), and (3) the inadequately tested Upper Cretaceous sediments downdip (south and west) from the surface exposures. Each of these provinces has recently developed an incentive for additional exploratory drilling.

The province of the pre-Mesozoic rocks in northwestern Alabama and northeastern Mississippi underlies the northeastward-thinning Upper Cretaceous rocks exposed at the surface and extends over into the Warrior basin of Northwest Alabama. In this all-but-forgotten area Union Producing Co. recently took an abandoned stratigraphic test (A on map) and completed it for a calculated open-flow potential of 35 M.M.c.f. of gas daily with an estimated 10 bbl. of 66°-gravity condensate per million cubic feet of gas. This well is producing from 5,186-5,274 ft. in the Mississippian-Chester (Hartselle?) which occurs in a sequence intermediate between that of eastern Oklahoma-western Arkansas and the Illinois basin. Union Producing now has a drilling well about ½ mile northwest of the discovery well and a location staked about 3 miles to the southeast of the completed test.

The province of the deep Mesozoic rocks was pointed out by A. I. Levorsen in his presidential address to the Geological Society of America (1948) as being one of the country's largest untested areas of regional updip wedging of porosity and permeability in known reservoir rocks: "This wedge is expanding at a rate of 100 ft. per mile down the dip and somewhere in Mississippi and Alabama it crosses the southwestern extension of the Appalachian arch setting up a potential trap area of thousands of square miles."

The same rocks that have produced so many prolific oil fields in East Texas, North Louisiana, and South Arkansas are deep in this area but,



as proven by George Vasen 1 fee, a 20,400-ft. hole in Stone County, Mississippi (C on map), Jurassic rocks are within reach of the drill even this far down the regional dip from the wedgeout. To the north of this deep wildcat, Jurassic and Lower Cretaceous rocks appear particularly promising because there are bound to be minor deformations and stratigraphic variations of the proper age to have localized the oil that regional studies would indicate had originally accumulated in this giant-size stratigraphic trap.

At B on map is Humble Oil & Refining Co. 1 Moye, discovery well of Pollard, Alabama's fourth commercial oil field. This well (Alabama's first flowing well, first light-oil well, and farthest-east producing well) was completed for more than 300 bbl. of 30°-gravity oil daily from the Upper Cretaceous - lower Tuscaloosa formation through perforations at 5,944-49 ft. The discovery is in the province of the inadequately tested Upper Cretaceous sediments of the southern portions of Alabama and Mississippi. Upper Cretaceous sands have yielded many oil fields to the west, but this eastern area has not seen sufficient deep-well drilling to open this promising province.

Since the discovery of Pollard field, an outpost drilled 1 mile eastward from the discovery well was completed dry after reaching 6,492 ft. Another outpost was drilled about ¾ mile southeast of the discovery to a depth of 6,510 ft. without finding oil in commercial quantities. Development of Pollard field is now beginning with the drilling of a direct south offset to the 1 Moye.

Despite the limited number of proofs of the productive capabilities of these three provinces, they are the targets of a rapidly reviving interest and combine to make up an area to watch for significant developments in the near future.

Philip C. Ingalls.

HIGHLIGHTS OF WEEK'S DEVELOPMENTS

ROCKY MOUNTAIN AREA.—Gulf Oil Corp. has a possible new discovery in the Big Horn basin. The well made some gas and distillate on test in the Phosphoria. A dual completion may be made at C. H. Murphy, Jr., 1 Unit, East Poplar, Montana, discovery, with the well flowing 650 bbl. of oil from Madison and 300 bbl. of oil from Charles. The well is the fourth discovery in the Montana portion of the Williston basin and the sixth in the U. S. portion of the basin since the Amerada Petroleum Corp. completed the discovery well.

NORTH LOUISIANA.—The fifth discovery of 1952 has been completed at Magnolia Petroleum Co. 1-A Wasson in Claiborne Parish. Well flowed 336 bbl. of oil and 501,000 cu. ft. of gas daily from perforations 10,194-206 ft. in the Smackover lime.

NORTH DAKOTA.—The second Beaver Lodge well has been completed at Amerada Petroleum Corp. 1 M. Iverson, extension 1 mile north of the Beaver Lodge discovery well in Williams County. Well flowed 545 bbl. of 42.9°-gravity oil daily from the Madison at 8,554-74 ft. The 1 Bakken, Tioga area, is coring below 13,668 ft., the deepest well to be drilled in North Dakota thus far.

Eastern Texas

Navarro County Reports Woodbine Sand Completion

DALLAS.—Humble Oil & Refining Co. 1 R. D. Grantham, Woodbine sand discovery 8 miles south of Kerens in Navarro County, pumped 129 bbl. of fluid a day on potential, being 25 per cent salt water, 12 per cent sediment and the balance 32°-gravity oil. Completion perforations were from 3,376-79 ft.

In Wood County, Humble 1 Yantis, Gas Unit 9, northeast of Yantis, was waiting on potential after flowing 36½ bbl. of oil a day from perforations at 8,060-70 ft. The flow was through ½-in. choke, with gas-oil ratio of 3,560 ft. Gravity was not reported.

A. O. Phillips 1 Mary Saner, wildcat 3 miles east of Pine Mills, was drilling below 7,450 ft. in sand.

Trans-Texas Drilling Co. 1 R. F. Walker, wildcat in the W. R. Buckley Survey, was drilling in shale at 3,760 ft.

In Marion County, Kemp Drilling Co. 1 Reed & Bitner, Mason & Shoemaker Survey, was drilling below 4,000 ft. Contract depth was 7,000 ft. and location is a northwest extension to the Woodlawn field.

E. G. Bradham 1 A. C. Irwin, Nacogdoches County wildcat southeast of Garrison, was drilling below 6,160 ft. in shale and lime.

Sohio Oil Co. was moving in rotary for a 9,000-ft. wildcat test 4 miles south of Martinsville. The test is the 1 A. D. Wood, in the J. Y'Barbo Survey.

Kerr-McGee Oil Industries 1 Hollingshead, wildcat southwest of Macomb, Grayson County, had operations under way and was below 2,855 ft. at last report.

Southwest of Hagerton, Shell Oil Co. 1 Mary Funk prepared to test on perforations at 7,017-22 ft. after treating with hydrafrac.

Northeast of Sadler, Star Oil Co. 1 Brooks, Dexter Survey, was drilling below 4,305 ft.

EAST TEXAS (DISTRICTS 5 AND 6) SUCCESSFUL WILDCATS

Anderson County: Anco Gas Corp. 1 M. E. Jackson Heirs, Rionda Grant Sur., 2½ mi. SW Tennessee Colony, TD 9,893 ft., perforated lower Rodessa 8,960-76 ft., IP 111 bbl. 45°-gravity oil, 9/64-in. choke, TP 700 psi., GOR 2,090 cu. ft.

Wood County: Sun Oil Co. 1 R. H. McCrary, Howington Sur., 4 mi. S. Winnsboro, TD 4,420 ft., elev. 479 ft., perforated sub-Clarksville 4,408-18 ft., IP pumped 223 bbl. oil.

EAST TEXAS (DISTRICTS 5 AND 6) WILDCAT FAILURES

Hopkins County: W. M. Coats 1 Bessie Reynolds, B. J. Watson Sur., dry, TD 5,161 ft., Woodbine 3,790 ft.

Wood County: Trans-Texas Drilling Co. 1 C. P. McKnight, M. Yarbrough Sur., dry, TD 6,428 ft.

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South Louisiana

Plaquemines Parish Records New Gas-Condensate Field

NEW ORLEANS.—A new gas-condensate field has been opened in the Magnolia area of Plaquemines Parish, at The Texas Co. 3 Bradish-Johnson, 20-18s-26e. Through a 5/16-in. choke, the well flowed 18 bbl. of clear white distillate on 8-hour gage. Tubing pressure was 4,100 psi, and gas-oil ratio 323,000/1. This wildcat was drilled to total depth of 13,074 ft., and perforated at 10,937-49 ft. On an early 3-hour test, through 3/16-in. choke, the well flowed 2,373,000 cu. ft. under tubing pressure of 4,075 psi.

Pan American Production Co. has made a second discovery on its large holdings in Cameron Parish. Final completion has been made at B-1 Miami Corp., 14-5s-4w, which flowed 265 bbl. of 35.3°-gravity oil daily through ¼-in. choke under tubing pressure of 3,985 psi. Well was drilled to 13,514 ft. in the Miocene, at which point mechanical difficulties precluded deeper drilling. Operator plugged back and completed through perforations at 12,508-70 ft. and 12,460-96 ft. This is on a 100,000 acre block on which Pan American holds leases and options. New discovery is located approximately 4 miles southwest of South Pecan Lake field, and has been designated Little Pecan Lake field.

Initial tests have been run at Woods Oil & Gas Co. 1 Dr. Benjamin Slater, 6-18s-27e, oil discovery in the Potash area of Plaquemines Parish. Through perforations at 11,215-27 ft., and 11,228-39 ft., the well yielded 240 bbl. of 34°-gravity crude daily through 8/16-in. choke. Tubing pressure registered 3,500 psi. Operator reports that a 101-ft. sand body was indicated in the well at 11,015-36 ft., 11,047-92 ft., 11,102-09 ft., 11,156-11,204 ft., and 11,210-39 ft.

Kerr-McGee Oil Industries, Inc., has completed a gas-distillate discovery in Cameron Parish at 1 C. F. Henry, 29-14s-9w. On final gage, the well flowed 71 bbl. of 52.1°-gravity distillate per day plus 2,467,000 cu. ft. of gas through 14/64-in. choke. Tubing pressure registered 3,450 psi. Test is bottomed at 9,428 ft., and production is from perforations at 9,356-66 ft.

Testing operations are underway at John W. Mecom and Freeport Sulphur Co. 1 Cockrell, 35-19s-26e, located on the north flank of Lake Washington field. Testing is through perforations at 11,872-11,930 ft. The wildcat had promising shows on electric log from 11,604-11,810 ft. and 11,880-11,936 ft.

SOUTH LOUISIANA WILDCAT FAILURES

Assumption Parish: Phillips Petroleum Co. 1 Rosedale, 79-14s-14s, dry, TD 14,190 ft.

Plaquemines Parish: The Texas Co. St. Ls. 1951 Blk. 16, in St. Ls. 1951 in Breton Sound, dry, TD 9,823 ft.

North Central Texas

New Strawn Area Develops In Northwest Jack County

WICHITA FALLS.—A new Strawn area was developing for northwest Jack County, some 5 miles southeast of nearest such pay, in Clay County.

S. D. Johnson 3 Rater, M. Putman Survey, had been completed from pay at 3,974-79 ft., total depth, gaging 206 bbl. of oil a day through 10/64-in. choke. Earlier this month the same operator's 2 Rater, same survey, was drilled dry to 3,403 ft. When the second well found pay section the 2 Rater was reentered and drilled to 4,012 ft. At last report the 2 Rater had produced 393 bbl. of oil in 11 hours and 50 minutes, through ¼-in. choke from pay between 3,980-90 ft. Johnson 1 Rater, same area, was drilling below 3,870 ft.

In Clay County, Armour Properties 2-C Scaling, 5 miles southwest of Joy, topped Strawn pay at 4,505 ft., drilled to 4,574 ft., then set casing at 4,500 ft. On potential test the well gaged 253 bbl. of oil a day through 20/64-in. choke. Location is about 1 mile southeast of the same company's 1-D Scaling, which was a recent Caddo discovery.

In Montague County, George S. Engle 1 Talley south Belcherville area, developed 1,000 ft. of clean oil on a 42-minute test at 5,346-53 ft. Engle's 1 C. M. McCall, wildcat 2 miles southeast of Nocona, was running oil string to 6,481 ft., total depth.

Tom B. Medders 1 E. Engenbacher, wildcat 3 miles southeast of Bowie, recovered mud on drill-stem tests at 6,078-6,111, 6,182-6,220 and 6,814-59 ft. A 2-hour test at 6,010-36 ft. recovered 1,000 ft. of gas-cut mud.

In Stonewall County, Continental Oil Co. 1 Viertel, 3 miles southeast of Aspermont, developed 477 ft. of oil and 173 ft. of mud on a 1-hour test in Canyon reef at 4,580-4,637 ft. After the test, casing was run to 4,966 ft.

Northeast of Peacock, Columbian Fuel Corp. 1 J. D. Patterson was drilling at 6,557 ft.

Northeast of Aspermont, Seaboard Oil Co. 1-A Boyd was in shale at 4,314 ft.

In the Taylor-Strawn area of Young County, Lebus Bros. 2-D Pace & Strange reported a daily potential of 568 bbl. of 42°-gravity oil. The flow was through ½-in. choke from pay between 3,470-3,526 ft.

NORTH CENTRAL TEXAS (DISTRICTS 9 AND 7-B) SUCCESSFUL WILDCATS

Callahan County: Elm Oil Co. 1 Olivena Loven, G. W. Denton Sur. 363, TD 1,736 ft., elev. 1,977 ft., pay 1,666-81 ft., IP pumped 46.5 bbl. 42°-gravity oil.

Coleman County: Louis Franklin 2 J. L. Boggus, 751-7-Manuel Martinez Sur., TD 1,503 ft., pay 1,498 ft., IP pumped 10 bbl. 39°gravity oil.

Tri-M Production Co. et al 1-H Mary Dunman, D. F. Roddan Sur. 76, TD 3,140 ft., elev. 1,826 ft., Morris sand confirmation well, pay 3,130 ft., IP 465 bbl. 42°-gravity oil, 10/64-in. choke, TP 300 psi., GOR 1,200 cu. ft.

Jack County: O. P. Leonard 1-A Mary Fields, O. Brown Sur., TD 1,745 ft., IP estimated 9,000,000 cu. ft. of gas.

Montague County: An-Son Petroleum Corp. 1 M. A. Hankins, Sec. 12, Hill CSL, TD 6,861 ft., elev. 1,061 ft., Viola lime pay 6,776-6,788 ft., IP pumped 20 bbl. 46°-gravity oil.

Throckmorton County: Noel Pautsky 1 T. W. Massey, Sec. 1,637, TE&L Sur., TD 4,169 ft., elev. 1,380 ft., Caddo pay 4,151-61 ft., IP 78 bbl. 42°-gravity oil, ½-in. choke, TP 75 psi., GOR 750 cu. ft.

Wise County: Greenbrier Oil Co. 1 C. R. Bridges, Blk. 99, Van Zandt CSL, TD 6,000 ft., conglomerate pay 5,462-80 ft., IP 4,800,000 cu. ft. of gas.

NORTH CENTRAL TEXAS (DISTRICTS 9 AND 7-B) WILDCAT FAILURES

Archer County: P. C. Burns 1 R. Horkey.

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Blk. 37, Meade LM Subd., dry, TD 1,550 ft.

Concho Petroleum Corp. 1 J. C. Doneghy, 4-A965-GH&RR, dry, TD 4,493 ft.

Harry F. Snebold 2 W. H. Taylor, 15-17-ATNCL, dry, TD 104 ft.

Callahan County: H. E. White 2 N. L. Williams, Sec. 46, LAL Sur., dry, TD 2,237 ft.

Coleman County: Wichita River Oil Co. 1-A McClatchey, 83-3-S. Perry Sur., dry, TD 1,692 ft.

Eastland County: McElroy Ranch Co. 1 M. E. Robinson, 5-3-H&TC, dry, TD 3,241 ft., elev. 1,591 ft., Lake sand 3,193 ft.

Jack County: S. D. Johnson 2 G. T. Rater, Blk. G., M. Putman Sur., dry, TD 3,403 ft.

Smith Construction Co. 1 L. B. Scaggs, SA&MG Sur., A-589, dry, TD 1,000 ft.

Montague County: Geo. S. Engle 1 Joe Benton, A. A. Lewis Sur., A-420, dry, TD 5,421 ft., elev. 898 ft., Caddo 5,890 ft.

Nolan County: Continental Oil Co. 1-248 Mary Dan Earwood, 248-64-H&TC, dry, TD 6,185 ft., elev. 2,493 ft., Canyon reef 4,642 ft.

Shackelford County: F. Craig Morton 1 J. A. Mathews, J. M. Srader Sur., dry, TD 1,252 ft.

Taylor County: D. E. Hughes 1 J. B. Wade, 25-18-T&P, dry, TD 4,760 ft.

Throckmorton County: F. H. Leatherwood 1 Eula Killman, 283-A165-BBB&C, dry, TD 4,919 ft.

Wichita County: T. H. Boroughs 1 H. C. Obenhaus, Blk. 276, Waggoner CSL, dry, TD 2,015 ft.

Wilbarger County: W. R. Simpson 1 W. T. Waggoner, Blk. 2, MK&T Sur., dry, TD 3,333 ft.

Young County: Carl G. Harris 1 E. C. Biggers, Sec. 1,924, TE&L Sur., dry, TD 3,600 ft.

Texas Gulf Coast

New Oil Discovery In Harris County Completed

HOUSTON.—Six miles southwest of Dayton, in Harris County, M. T. Halbouty and SoRelle & SoRelle have completed 1 W. D. Rogers unit for a new oil discovery. From perforations at 8,948-64 ft., the well flowed 120 bbl. of 33.6°-gravity oil daily through a ¼-in. choke. Tubing pressure was 350 psi. Well is located in the West Esperson area, Duncan Survey.

A new oil pool has been opened 1¼ miles north of Weesache, Goliad County, at F. William Carr 1 Emma Haynes. The wildcat has been completed for 160 bbl. of 38°-gravity oil daily through a ⅛-in. choke. Production is from perforations at 7,620-24 ft. Tubing pressure on the test was 760 psi. Hole is bottomed at 7,880 ft. with 5½-in. casing cemented at 7,680 ft. Well is located in H. T. Callihan Survey.

Four miles east of Village Mills in Hardin County, Harry Hampton has established new oil production at 1 Olive Sternenberg, located in the Beech Creek area. Through perforations at 6,235-36 ft., the well flowed 128 bbl. of 44.5°-gravity oil daily through 6/64-in. choke. Hole is bottomed at 7,225 ft.

A three-quarter mile southeast extension to Helen Gohlke field, Victoria County, appears in the offing at Sun Oil Co. 1 Charles Kuester. On 20-minute drill-stem test of interval 8,122-40 ft., using ¼-in. chokes, recovery was 3,000 ft. of clean oil and 90 ft. of oily mud. Bottomhole flowing pressure gaged 1,725 psi. On test of perforations at 8,015-25 ft. recovery was 160 ft. of oil through ¼-in. chokes. The last test, 21-minutes at 8,142-56 ft., recovered 4,000 ft. of oil. This well is ¾ mile southeast of gas-distillate production at Helen Gohlke.

A second test has been completed in the Hicksbaugh area of Tyler County, at Midstates Oil Corp. 1 J. T. Wurtsbaugh. From perforations in the 8,500-ft. zone, the well flowed 143 bbl. of 40°-gravity oil daily through 9/64-in. choke. Tubing pressure gaged 1,550 psi., and there was no water in the flow. Although exact perforations have not been disclosed, it is believed that the well was completed around 8,410-23 ft. where oil was recovered on 10-minute drill-stem test. Hole was drilled to 8,926 ft. and plugged back to 8,535 ft. for completion. Hicksbaugh production was opened in 1949 at Humble Oil & Refining Co. B-1 William Rice Institute, which flowed 41 bbl. of 39.6°-gravity oil daily through perforations at 8,480-83 ft. The Wurtsbaugh well is 1,000 ft. east of Humble's discovery well.

TEXAS GULF COAST (DISTRICTS 2 AND 3) SUCCESSFUL WILDCATS

Brazoria County: Oil discovery—The Texas Co. 1 John W. Harris et al, Asa Brigham Sur. A-47, TD 11,955 ft., perf. 10,610-17 ft., IP 213 bbl. oil per day, 38.7°-gravity, TP 450 psi.

Fayette County: New pay at Muldoon-Hamon Oil & Refining Co. 3 Tuna et al, John Vivien 1/3 League, TD 2,333 ft., open hole 2,326-33 ft., IP 107 bbl. oil per day, 13/64-in. choke, TP 85 psi., 21°-gravity.

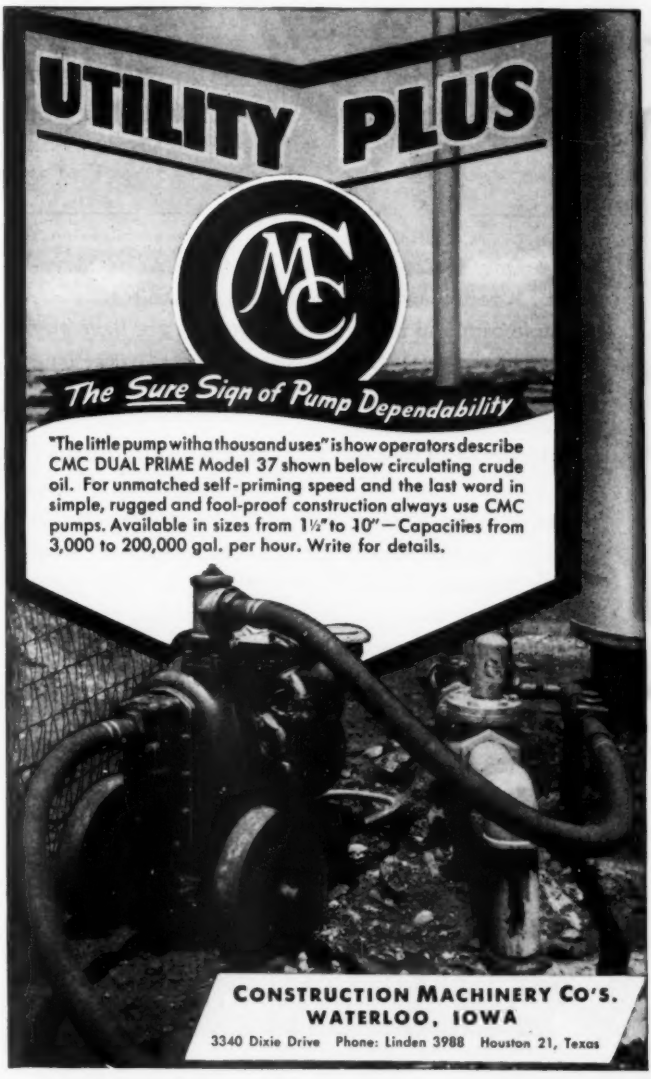
Liberty County: Oil discovery—"Quinn"—Sohio Petroleum Co. 1 B. E. Quinn, Jr., James Humphreys Sur. A-212, TD 10,962 ft., perf. 7,370-73 ft., IP 92 bbl. oil per day, 10/64-in. choke, TP 200 psi. 36.8°-gravity.

Polk County: Oil discovery—Jordan Drilling Co. & Kraftex Enterprises, Ltd., 1 Wiggins, G. S. Thomas Sur. A-72, TD 8,257 ft., Wilcox 7,841-53 ft., IP 174 bbl. oil per day, ¼-in. choke, TP 1,850 psi. 49.1°-gravity.

TEXAS GULF COAST (DISTRICTS 2 AND 3) WILDCAT FAILURES

Lavaca County: John B. Coffee 1 William Borchers, William Heaford Sur. A-233, dry, TD 4,010 ft.

Refugio County: S. R. Chamberlain B-1 Mrs.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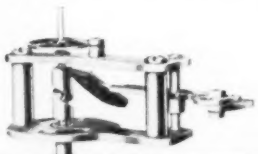

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Victoria County: Goldston Oil Corp. & Great Lakes Carbon Corp. 1 Bankers Mortgage, S. A. Belding Sur. A-145, dry, TD 6,500 ft.

Louisiana-Arkansas

Fifth Discovery of Year Completed in Claiborne

SHREVEPORT.—The fifth discovery of 1952 has been completed at Magnolia Petroleum Co. 1-A Wasson, 13-22n-5w, 1 mile southwest of Summerfield, Claiborne Parish. The wildcat was completed to flow 336 bbl. of 50.8 -gravity oil and 501,000 cu. ft. of gas daily from perforations 10,194-206 ft. in the Smackover lime.

The discovery may be a possible dual completion as perforations 10,420-60 ft. proved productive on a 9-hour test, flowing 77 bbl. of 53 -gravity oil. Total depth is 11,188 ft.

Stanolind Oil & Gas Co. is drilling in the same area along a fault thought to be in the area at 1 Hannah Rainach unit, 17-22n-5w. Well is drilling sand and shale below 6,440 ft.

Southwest Gas Producing Co. has completed 1 Shadow, 12-19n-2w, 1 mile east of Unionville field, Lincoln Parish. Well is awaiting state gage. The wildcat was completed from 8,865-71 ft. in Vaughn sand, and will possibly be called an extension to the gas-distillate Unionville field.

Casing was set to 8,949 ft., and on a 5-minute drill-stem test of perforations 8,865-71 ft. the well recovery was 46 ft. of condensate, 88 ft. of water cushion and mud and 18 ft. of gas-cut mud.

A northeast diagonal offset test, confirmation well of Helena field in Tensas Parish, has failed, but drilling is continuing in search of a deeper producing zone. The well is Atlantic Refining Co. 1 Sarah Butts, 12-10n-10e, offset to 1 H. T. Goldman, the discovery well. The 1 Goldman was completed in the basal Tuscaloosa at 8,912-27 ft. The 1 Sarah Butts found no productive sand in the basal Tuscaloosa. Proposed drilling depth is now about 9,500 ft.

Production pipe has been run at Mid-Century Oil & Gas Co. 1 Dr. W. B. Worley, C SE NW 5-13n-15w, De Soto Parish. The well, confirmation to the discovery well 1 Williams, is at total depth of 5,400 ft. The discovery well, 1 Williams, 7-13n-15w, was completed from 5,360-68 ft. in Gloyd. Well made 13,500 M.c.f. of gas daily plus 4-5 bbl. condensate per million, total depth 5,378 ft.

Arkansas.—The Arkansas side of the new Webster Parish Springhill field gained its first completion at Pan-Am Southern Corp. 1 Lucy Burns et al, 7-20s-22w, Columbia County. Well flowed 152 bbl. of 39°-gravity oil daily from perforations 3,099-3,103 ft. in the Tokio sand.

Curtis Kinard has staked location for a Smackover wildcat at 1 Taylor, C SE NE NW 28-18s-12w, north of Strong in southern Union County. The wildcat is located just west of the depleted Smackover discovery well, Root Petroleum 1 Union Saw Mill, C NW NW 27-18s-12w. Production will be sought to 6,500 ft.

In Ouachita County C. A. Lee Drilling Co. is pumping 3-4 bbl. of oil daily at 1 B. I. Graves, C W½ NE SW 8-14s-18w, from perforations 1,854-56 ft. in Nacatoch. Depth drilled is 2,220 ft. and pipe is set at 2,020 ft. for a completion try. Stephens Production Co. is waiting on pump at 1-A Wesson, NE SE SW 3-15s-19w, 2 miles east of Curry field, after swabbing 2 bbl. of oil in 8 hours from Nacatoch.

LOUISIANA SUCCESSFUL WILDCATS

Bienville Parish: Pan-Am Southern Corp. et al 1 Southern Advance Bag & Paper Co., C SE SW 17-17n-6w, 8,500 M.c.f. of gas from Hosston 6,917-24 ft., TD 8,030 ft. (discovery tentatively named West Bryceland).

Webster Parish: L. L. Robinson et al 1 Kil-

How you

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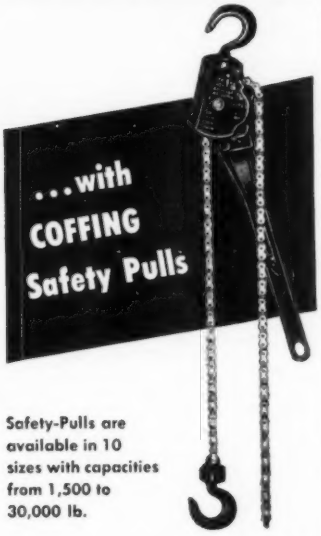

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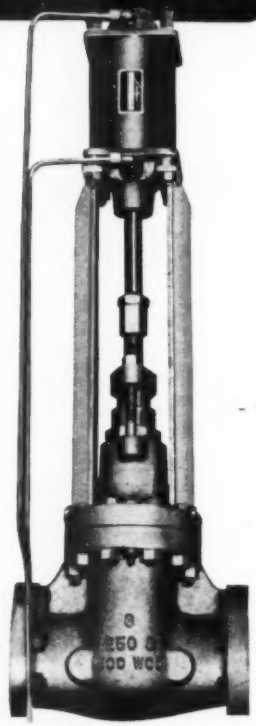

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patrick, 293 ft. S and 1,652 ft., E NWc 6-23n-10w, flowed 216 bbl. 39.3°-gravity oil from Tokio 3,104-10 ft., TD 3,153 ft. (discovery well Springhill field).

Permian Basin

First New Pay Strike In Jameson Field Completed

MIDLAND.—Discovery of Strawn sand production on the western edge of the Jameson limestone field has given the area a drilling boom. First well in the new pay was Chester Hunter, Dallas, 1 E. E. Stagner, S. M. Conner Survey, which completed for 141 bbl. of oil a day from fractured pay at 5,925-6,095 ft. Sun Oil Co. had six rigs running and Hunter had a north offset under way, all scheduled to test the Strawn sand.

Location of the new-pay area is about 3 miles north of the Lygay-Strawn sand field which lies on the south side of the Colorado River.

Sun had an east offset to the discovery ready for completion, and its 9-A Mathers was ready to drill plugs at 5,120 ft. and drill ahead to 6,100 ft. It had the oil sand high at 5,806 ft.

In extreme southwestern Scurry County, McAlester Fuel Co. 1-A Allen, 75-20-Lavaca Navigation Co. Survey, found top of a reef section at 7,304 ft., on elevation of 2,279 ft. A 2-hour drill-stem test in the lime, from 7,308-34 ft., had gas in 16 minutes and recovered 55 ft. of clean oil and 335 ft. of heavily oil and gas-cut mud. Operators were coring ahead.

The reef top, picked by samples, checked 106 ft. high to Standard Oil Co. of Texas 1 Dunn, 2½ miles to the southwest in Mitchell County, but somewhat lower than Standard-Fryer 1 Allen, dry hole 2 miles west. Because of difference in tops in the latter well, the 1-A Allen was reported to be either 29 or 74 ft. lower on the reef.

In northeastern Scurry County, The Texas Co. 196 Fuller, wildcat in Section 1, Kuykendall Survey, was swabbing an average of 11½ bbl. of fluid an hour. Recovery in 22 hours from perforations at 7,068-98 ft., in the Strawn, was 251 bbl. of fluid, being 70 per cent oil.

Sinclair Oil & Gas Co. 7 June Tippett, north outpost to production in the north extension area of the Pegasus field, prepared to run casing and make a production test in the Pennsylvanian. Total depth was 10,733 ft.

Sinclair 4 June Tippett, Spraberry operation in the northwest part of the Pegasus field, was making mostly salt water. Recovery in 15 hours of swabbing was 4 bbl. of new oil and 44 bbl. of salt water.

In Val Verde County, Phillips Petroleum Co. 1 Delta-Wilson was drilling below 14,029 ft. in lime and shale, making slow progress in the hard formation.

In Schleicher County, Delta Gulf Drilling Co. 1 Boyd developed a good show of oil and gas on drill-stem test in Canyon sand between 4,420-33 ft. Recovery was 1,030 ft. of oil, 810 ft. of oil and mud, and 210 ft. of oil and gas-cut mud. Location is in 9-H-GH&SA.

WEST TEXAS (DISTRICTS 8 AND 7-C) SUCCESSFUL WILDCATS

Cochran County: Coline Oil Corp. 1-A Bledsoe, 5-Y-PSL, TD 4,845 ft., elev. 3,987 ft., San Andres 3,936 ft., pay 4,714 ft., IP pumped 62 bbl. 26°-gravity oil.

Runnels County: American Trading & Production Co. 2 E. W. Bridwell, J. Smith Sur. 60½, TD 4,000 ft., perforated McMillan sand 3,499-2,502 ft., IP 254 bbl. 44°-gravity oil, ½-in. choke, TP 75 psi., GOR 322 cu. ft.

Pan American Production Co. 2 Nettie Currie, Sec. 163, ETRR Sur., TD 3,467 ft., elev. 1,697 ft., perforated 3,440-52 ft., IP pumped 29 bbl. 42°-gravity oil.

Upton County: Sinclair Oil & Gas Co. 6 McElroy Ranch, 132-D-CCSD&RGNG, TD 12,867 ft., PB 9,953 ft., elev. 2,847 ft., Pennsylvanian 9,714 ft., pay 9,810-75 ft., IP 65 bbl. 43°-gravity oil ½-in. choke TP 500 psi.

WEST TEXAS (DISTRICTS 8 AND 7-C) WILDCAT FAILURES

Andrews County: E. M. Craig, Jr. 1 Bradford, 22-A48-PSL, dry, TD 9,015 ft., elev. 3,340 ft., Clear Fork 6,410 ft., Mississippian 8,920 ft.

Crockett County: John L. Boyd 1 J. M. Shannon-Pure, 58-GH-GC&SF, dry, TD 1,350 ft., elev. 2,495 ft., San Andres 1,020 ft.

Dawson County: Stanolind Oil & Gas Co. 1 L. C. Bodine, 43-33-T4S-T&P, dry, TD 264 ft.

Garza County: Cosden Petroleum Corp. 1 T. H. Tipton, Sec. 1,306, P. H. Talley, TTRR Sur., dry, TD 8,861 ft., elev. 2,948 ft., Spraberry 4,890 ft., Pensylvania 7,060 ft., Strawn 8,464 ft., Mississippian 8,810 ft.

Howard County: Stanolind Oil & Gas Co. 1-A W. T. Barber, 45-31-T1N-T&P, dry, TD 9,960 ft., elev. 2,407 ft., Spraberry 5,370 ft., Dean 6,240 ft., Fusselman 9,125 ft., Ellenburger 9,330 ft.

Kent County: Geo. Calliahn 2 W. G. Williams, 60-5-H&GN, dry, TD 2,606 ft.

Lynn County: Anderson-Prichard Oil Corp. 1 Mrs. B. E. White, 154-A895-HE&WT, dry, TD 10,841 ft., elev. 3,239 ft., Spraberry 6,580 ft., Pennsylvanian 9,750 ft., Mississippian 10,270 ft., Ellenburger 10,790 ft.

Martin County: Argo Oil Corp. 1 Robert B. Brown, 15-36-T2N-T&P, dry, TD 10,606 ft.

The Texas Co. 1 G. B. McClain, 38-36-T2N-T&P, dry, TD 11,600 ft., Spraberry 7,790 ft., Pennsylvanian 10,448 ft., Devonian 11,408 ft.

Pecos County: Nelson Bunker Hunt Trust 1 W. A. Stroman, Sec. 526, Comanche Creek Irrigation Co. Sur., dry, TD 16,025 ft., elev. 2,921 ft.

Reagan County: Sinclair Oil & Gas Co. 1 University-Reagan, 36-2-University, dry, TD 7,500 ft., elev. 2,633 ft., Spraberry 6,339 ft., lower Spraberry 6,907 ft.

Runnels County: Aztec Oil Co. 1 Woodward Heights, Sec. 366, 1 Larget Sur., dry, TD 4,050 ft., Morris sand 3,550 ft., Caddo 3,998 ft.

Terry County: Hunt Oil Co. 1 W. M. Adams, 148-T-D&W, dry, TD 10,519 ft., elev. 3,310 ft., San Andres 4,780 ft., reef 10,495 ft.

Tom Green County: M. H. McKinney 1 Mark B. Sullivan, Sec. 195, J. Seiler Sur., dry, TD 5,450 ft., elev. 1,951 ft., Permo-Pennsylvanian 5,132 ft.

SOUTHEASTERN NEW MEXICO

Buffalo Oil Co. 12-B Baish was still testing and showing some fresh water. After recementing 5½-in. casing, the well flowed 502 bbl. of oil and 22 bbl. of fresh water in 24 hours. Later, on gas lift, the well flowed 375 bbl. of oil a day and 50 bbl. of water.

Humble Oil & Refining Co. 1 Federal-Elliott, southeast of the Saunders field, was coring at 14,020 ft. A drill-stem test from 13,121-78 ft., open 2 hours, had gas in 13 minutes, water blanket in 14 minutes and gas-distillate in 30 minutes.

Magnolia Petroleum Co. planned to reenter its 1 Black in 9-15s-36e and drill ahead to 13,500 ft. to test the Devonian. The well was completed in 1951 at 11,502 ft., at which time it pumped 156 bbl. of oil a day from the Pennsylvanian.

American Liberty Oil Co. made location for a 10,500-ft. wildcat as its 1 State-Sun in 12-16s-35e. Contract depth was expected to explore the Devonian.

Great Western Drilling Co. moved in to deepen George P. Livermore 1 David Bilberry, 1-7s-37e, southeast Roosevelt County. The well was drilled dry to 4,450 ft. in 1951. Projected new total depth of 9,000 ft. was to test the Siluro-Devonian.

Joseph O'Neill, Jr., et al 1-A State, 36-20s-38e, recovered 3,780 ft. of gas, 50 ft. of free oil and 120 ft. of heavily oil and gas-cut mud on a 3-hour drill-stem test in the lower Drinkard zone at 7,439-79 ft.

Drilling continued on a 10,000-ft. Ellenburger contract. Location is about 2 miles northeast of Fullerton Oil Co. 1 Elliott, recently completed lower Drinkard discovery.

SOUTHEAST NEW MEXICO SUCCESSFUL WILDCAT

Lea County: Shell Oil Co. 1 Chesher, 12-21s-37e, TD 7,695 ft., elev. 3,465 ft., Abo 6,830 ft., pay 6,919 ft., IP 144 bbl. 40°-gravity oil, 24/64-in. choke, TP 100 psi., GOR 699 cu. ft.

SOUTHEAST NEW MEXICO WILDCAT FAILURES

Eddy County: Carper Drilling Co. 2 Ralph Shugart, 22-20s-26e, dry, TD 1,625 ft., elev. 3,270 ft., San Andres 1,460 ft.

Roosevelt County: Gulf Oil Corp. 1 State "T", 16-8s-38e, dry, TD 4,845 ft., elev. 3,992 ft., San Andres 3,950 ft.

Canadian Fields

Devonian Oil Discovery Reported in Nevis Area

CALGARY.—The general Stettler region of central Alberta, around 95 miles northeast of Calgary, has yielded its fifth Devonian oil discovery for Canadian Gulf Oil Company within a three year period. The latest discovery, Gulf 4 Lambert, in the Nevis area, around 14 miles west of Stettler Devonian oil wells, struck its crude oil during drill-stem test.

The Nevis discovery well, on LSD 4, 32-38-22w4, was rated as a D2 natural gas and distillate discovery. Drill-stem tests in that horizon indicated around 50 ft. of zone, and gas flowed at rates up to 8,000,000 cu. ft. daily. Some distillate was also recovered during the tests. After entering a thin section of Green shale formation the hole was deepened, and entered a porous natural gas with some distillate, and gas rates reached a volume of 12,000,000 cu. ft. daily.

The oil discovery at 4 Lampert came during drill-stem test from 5,622 to 5,632 ft. Valve was open for 30 minutes, and a flow of natural gas reached the surface in ½ minute, mud and oil sprayed in 3½ minutes, and oil and gas sprayed in 4 minutes. Pipe recovery was 215 ft. of clean oil with gravity around 36°, no water. Good porosity was encountered in the 10-ft. cored section that was last drill-stem tested, and the gas-oil ratio during test was reported to be very high. Further coring and testing in this productive Devonian section will likely be carried out soon.

Gulf's first strike in the Stettler region was made in mid-1949 at 4 N. J. Ellis. That well discovered oil in both the D2 and D3 zones of Devonian. In the Big Valley area, around 16 miles due south of Stettler, Gulf also made a discovery of Devonian oil. About mid-way between that 16-mile stretch separating Stettler and Big Valley fields, Gulf made another Devonian discovery. That strike was in the Caprona-Fenn area, where the company also obtained some oil encouragement in the Lower Cretaceous at a previous wildcat venture. The company's other discovery in the general Stettler region was made at a venture located a few miles south of the main producing sector of Stettler. A small D2-D3 oil pool is indicated in this area, but does not appear as substantial as the Nevis discovery and the three other oil strikes.

Kelcam Oils, Ltd., Edmonton independent, has discovered natural gas and heavy crude oil at its exploratory venture in the Saddle Lake area of central east Alberta, according to unofficial but reliable reports. The well indicated its discovery during drill-stem tests in the Lower Cretaceous below 1,550 ft. Production string of casing has been set preliminary to further testing operations.

The discovery well, Kelcam 1 Cork, on LSD 2 9-58-11w4, is about 12 miles west of St. Paul gas wells and around 75 miles northeast of Edmonton. Natural gas first came in around 1,570 ft., and several drill-stem tests in the gas section gave flow rates ranging up to 1,500,000 cu. ft. daily. Good showings of oil-cut mud and heavy crude oil were obtained in the section below the gas sand, to around 1,620 ft. It is understood that the gas and oil productive sand is between the interval 1,570 and 1,620 ft. interval.

Two Toronto firms, Punch Petroleums, Ltd., and Rio Tinto Oils (Alberta), Ltd., have found indications of oil and natural gas during their exploratory structure test drilling program currently being carried out in the Northwest Territories, around 130 miles north of the Alberta border and some 600 miles north of Edmonton.

The structure test well gave its first indications of oil and gas at the shallow depth of 365 ft., according to company reports. A porous limestone, the Slave Point lime, was encountered from 365 ft. to bottom 456 ft., and showed good oil saturation in cores, plus evidence of natural gas. The porosity was both vugular and intergranular, and varied throughout the 90 ft. of section penetrated. Company engineers estimated the gravity of the oil at between 25-30°-gravity, but it is not as yet possible to determine whether the find will yield in commercial volume, as the small 2-in. diameter structure test hole cannot be further tested.

CANADIAN WILDCAT FAILURES

Cal-Standard-Province 1 Atikameg, LSD 4 22-80-12w5, TD 5,513 ft.

Carmangay 1 LSD 16 32-13-22w4, TD 6,531 ft.

Cal-Standard 11-18 Chigwell LSD 11, 18-41-24w4, TD 6,800 ft.

New Devon 16-4 Scona LSD 16, 4-52-24w4, TD 4,597 ft.

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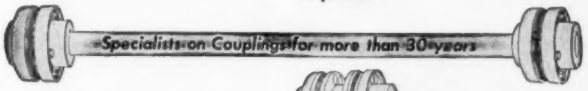

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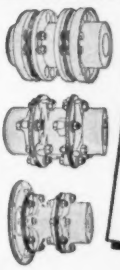

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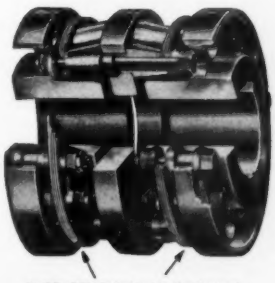

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Cal-Standard 1 Francis Lake LSD 4, 26-66-26w4, TD 4,829 ft.
Imperial-Golden Spike 7-3 North LSD 7, 3-52-27w4 TD 6,605 ft.
Imperial 8-24 Woodbend East, LSD 8, 24-51-26w4, TD 6,185 ft.
Stanolind 1 Otter Lake, LSD 4, 29-9-12w5, TD 5,393 ft.
Calnorth 1 Red Deer Lake, LSD 16, 21-44-22w4, TD 5,600 ft.

EASTERN CANADA

Contracts have been let by Western Ashley Minerals, Ltd., to Geo. H. Rawlings of Chatham for drilling on the Beatty lease, comprising 650 acres, in the Wardsville area of Middlesex County. Some 4,500 acres are being leased south and east of the immediate Wardsville development, and drilling will be started as soon as a rig can be moved in.

The Western Ashley test is the first stage in a comprehensive development program in southwestern Ontario. Areas to be developed include Aldborough township, in Elgin County; Lobo and Moss townships in Middlesex; Sombra, in Lambton; Rochester and Tilbury West in Essex and Camden, Dover, Raleigh and Romney, in Kent County. Western Ashley is entirely financing the Wardsville test in Mosa township; but Anchor Petroleums will have 50 per cent participation in the other drilling. As some of the areas are regarded as proven, negotiations are under way to market gas to large industrial concerns and plans are being made for feeder gas lines.

In Bruce County, leasing for oil is being carried on by Imperial Oil along the North Saugeen River, between Paisley and Chesley. The area is southwest of Owen Sound. In this area Imperial has no plan for immediate drilling. In the Kincardine area, farther south and west, interests associated with Sun Oil Co. have leased 1,000 acres in Huron township.

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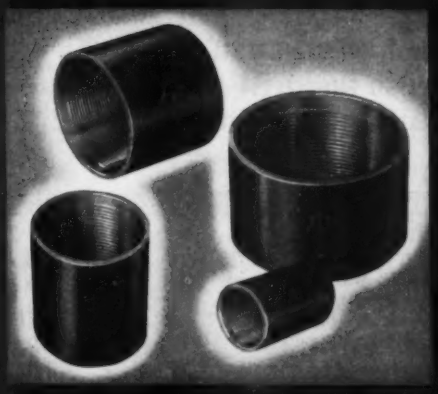

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Southwest Texas

Potential Test Run At Hidalgo Gas Discovery

CORPUS CHRISTI—Potential test has been run at Houston Oil Co. of Texas-American Republics Corp. 1 Temple W. West et al gas discovery 5 miles east of Sam Fordyce field production in Hidalgo County. From perforations at 6,048-58 ft., the well flowed 36,500,000 cu. ft. of gas daily plus an ungaged amount of distillate on open flow. No pressures have been reported on the well, however, while cleaning on ¼-in. choke, a flowing pressure of 2,000 psi. developed. Discovery is located in Porcions 73, 74 and 75.

Oil has been recovered at Nueces County venture in a gas producing area near Agua Dulce. Pan American Production Co. 3 Luruth Smith Rivers, Baily field project, penetrated the King sand from 5,449-61 ft. On 15-minute drill-stem test at 5,451-57 ft., recovery was 19 stands of oil with a maximum working pressure of 54 psi. Another test was conducted at 5,457-67 ft., using ½-in. chokes, and the well yielded 34 stands of 37.4°-gravity oil with working pressure of 60 psi. Bottom-hole flowing pressure was 2,435 psi. This oil discovery is located only 2,800 ft. southeast of a gas-distillate well. Location is in Rafael Garcia Survey, A-120.

Upper Rosenberg exploration in Webb County gained impetus with another discovery in the Tal Vez area. G. G. Mortimer, Jr., 1 R. E. Welhausen, wildcat 2½ miles southwest of Tal Vez production, has set casing to test an indicated 16-ft. sand in the Rosenberg. A drill-stem test at 1,882 ft. recovered 75 ft. of free oil. This well was projected to the massive Rosenberg around 2,000 ft., and operator will carry the well on down and core that sand.

Production gage has been run at a new Hiawatha sand strike 5 miles south of Realitos in Duval County. Discovery is Pontiac Refining Co. 1 Leroy Denman which flowed 77 bbl. of 45°-gravity oil daily through a 7/64-in. choke. Well is production from perforations at 5,048-56 ft. Location is in Lot 2, Block 14, Realitos subdivision. Meanwhile, Pontiac has set cement plug at 4,000 ft. in A-1 Denman, south offset to the discovery. Projected depth is 5,200 ft.

A new producing horizon has been established in Fulton Beach West field, Aransas County, at Phillips Petroleum Co. 31 Copano Bay State, Tract 17. From perforations at 6,252-62 ft., well flowed 120 bbl. of oil daily through ⅛-in. tubing choke. Flowing tubing pressure gaged 750 psi. New sand has been designated A-5.

SOUTHWEST TEXAS (DISTRICTS 1 AND 4) SUCCESSFUL WILDCAT

Bastrop County: New pay in unnamed field Thomas Jordan, Inc., 2 H. N. Bell, Jr., Albert Block Sur., 975 ft. SW of 1 discovery well, TD 3,280 ft., perf. 2,847-2,90 ft., IP 220 bbl. oil per day on pump, 16°-gravity.

SOUTHWEST TEXAS (DISTRICTS 1 AND 4) WILDCAT FAILURES

Atascosa County: Martin, Shelly & Thomas 1 Nellie Dinsmore, John Bryan 238 Sur., dry, TD 2,212 ft.

Brooks County: Blanco Oil & Al Buchanan 2 D. Gottlieb et al, B. Elizondo, Sec. 570, dry, TD 2,754 ft.
C. F. Falley 1 F. J. & H. J. Gravis, E. D. Gravis Sur. 88, A-1649, dry, TD 3,828 ft.

Jim Hogg County: Armstrong & Cotton, Inc., 1 Down Royalty Corp., El Javali Grant, Beer & Coffee Subd., Blk. 51, dry, TD 2,338 ft.

McMullen County: Howeth & Mason 1 La Chusa Land Co., AB&N 45 Sur., dry, TD 1,738 ft.

San Patricio County: Austral Oil Exploration Co., Inc., 1 D. I. Coogin, Geo. H. Paul Subd. of Coleman Fulton Pasture Co. Lands, C. F. Delmas Sur., A-104, dry, TD 9,761 ft.

Webb County: Delhi Oil Corp. 1 A. M. Bruni, Mariano Arispe Grant, Share 5, Blk. 14, dry, TD 3,991 ft.

O. W. Killam 1-99 Bruni Est., Ranchito Pasture Borrego Grant, dry, TD 2,683 ft. Killam & Hurd et al 1 A. M. Bruni Est., Sur. 3, 1 N of Aguilares, dry, TD 1,453 ft.

Mississippi

Good Wilcox Shows Found At Adams County Venture

JACKSON.—Approximately ¾ mile northeast of Kingston field production, Adams County, J. P. Evans et al, have set casing to 6,620 ft. to test some excellent Wilcox shows in 1 A. K. Ellis, 12-5n-2w. Electric log and sidewall cores indicated oil sand at 6,456-62 ft., 6,490-92 ft., and 6,506-26 ft. The 20 ft. of saturation at 6,506-26 ft. is in the top part of a thick sand with no shale break separating the oil and salt water, but it is thought that the section is thick enough to afford a good completion. Operators plan to perforate at 6,507-11 ft. for completion attempt.

In the recently discovery Pollard field, Escambia County, Alabama, Humble Oil & Refining Co. has abandoned 1 Finlay et al, 18-1n-9e, second confirmation test to the field discovery. Well was located one-half mile east and one-half mile south of the discovery. Top of lower Tuscaloosa was reported at 6,007 ft. which is 111 ft. lower structurally than in the discovery well. Log has not been released on the well.

Stanolind Oil & Gas Co. has secured a permit to drill a Smackover test on the west edge of the City of Jackson, which will be the second deep test to be drilled on Jackson dome. First well was in 25-6n-1e, which was State of Mississippi 2 Fee, completed early in 1937 at total depth of 5,530 ft.

In southwestern Franklin County, Mississippi, Serio-Bartlett have abandoned 1 W. L. Cobb, 30-5n-1e, after 3 drill-stem tests failed to establish commercial production in a tight Wilcox sand that carried shows of oil. Test is bottomed at 7,010 ft. In Wilcox, and sidewall cores indicated oil shows at 6,323-27 ft., 6,352-64 ft. and 6,371-74 ft. Drill-stem test at 6,359-61½ ft. recovered 50 ft. of oil and 60 ft. of oil-cut mud on 10-minute test. Bottom-hole flowing pressure was only 300 psi. Only salty mud and water cushion were recovered on test at 6,322-24½ ft. A third test at 6,351-64 ft. recovered 180 ft. of oil and gas-cut mud and 300 ft. of oil. Bottom-hole flowing pressure was 325 psi.

Honolulu Oil Corp. and Gulf Refining Co. have staked location for a Smackover test in NE NE 19-8n-8e, Scott County. Last year, Honolulu drilled 1 Board of Supervisors, 16-5n-9e, Scott County, and abandoned the well after drill-pipe was stuck and several attempts to sidetrack were unsuccessful.

MISSISSIPPI—SUCCESSFUL WILDCAT

Adams County: New pay at Stanton—Austin Stewart—R. H. Alagood 1 Lettie Proby et al, 41-8n-1w, TD 6,158 ft., Wilcox 3,980-81½ ft., IP 24,000,000 cu. ft. of gas per day, open flow, TP 1,562 psi.

MISSISSIPPI WILDCAT FAILURE

Franklin County: B. Serio—R. J. Bartlett 1 W. L. Cobb, 30-5n-1e, dry, TD 7,007 ft.

California

Castaic Hills Link Test Is Closely Watched

LOS ANGELES. — Wildcat and development activity in the vicinity of Castaic Junction in upper Santa Clara Valley, Los Angeles County, continued to attract attention.

Most closely watched well was The Texas Co. 10 Honor Rancho-1, a link test located midway in the ¾-mile stretch which separates Castaic Hills from Honor Rancho field. A formation test at 5,836-94 ft. was unsuccessful because of mechanical failure. A second test then was made at 5,852-6,000 ft. but results of this test were not revealed. Late field reports on the important extensioner showed it drilling in sand and shale at 6,029 ft.

Tending to confirm what some geologists believe to be the case—that one or other of three sands will be productive along the more than 2-mile Honor Rancho-Castaic Hills trend—Texaco completed 9 Honor Rancho to bring the two areas one location closer together. The extensioner flowed 36.6°-gravity crude at the rate of 550 bbl. daily through a 14/64-in. choke from about 6,360-6,488 ft. On the east side of the field the company was getting under way with a ½-mile extension attempt, 2 Honor Rancho-2 in SE NE 6-4n-16w.

In Castaic Hills the field's third dry hole was recorded by Wood Callahan Oil Co. 36-1 Castaic. Furthest south of the seven drilling wells in the field, in SE SW 36-5n-17w, it failed to find the Sterling sand after drilling to 7,003 ft. That it is located only some 400 ft. southwest of Texaco's recent extensioner indicates the area will be tricky developing because of faulting.

Slightly over ½ mile north of the Wood Callahan well, in NE NW 36, Continental Oil Co. was in the process of completing the field's fourth producer. Located about ½ mile east of the discovery and about that distance northwest of the Texas Co. extensioner, a 7-in. combination string containing 90 ft. of perforations on bottom was landed at 5,427 ft.

East of Castaic Junction field ½ mile, Standard Oil Co. of California was below 11,823 ft. at its 6 Newhall Land & Farming. Outcome of this important extension attempt should be known shortly. Humble Oil & Refining Co. was preparing to run a formation test at 12 Newhall Land, a one location north stepout in the central part of the field, after coring several hundred feet to 10,414 ft.

In Ventura County's Montalvo area, Standard of California completed 1 Pidduck as a ¾-mile northeast extension. Located in 20-2n-22w, the wildcat, possibly a new pool opener, was completed in the lower McGrath sand at 9,860-9,913 ft. Pump difficulties prevented a true gage of the well's productivity but it is thought capable of exceeding 75 bbl. daily of 26°-gravity crude.

Among the new wildcats staked were two gas tests in Yolo County. About ¾ mile east of Pleasant Creek production, Mohawk Petroleum Co. staked 1 Shell-Pleasant Creek Unit-2 in SW SE 8-8n-1w. Northwest of Winters gas production, in NE NW 13, the same company will drill 1 Winters Community-1.

In Kern County, activity in vicinity of Gosford field is being revived after a lull of several months. Hancock Oil Co. staked location for 43-14 Kern County Land about 1 mile northwest of the field, in 14-20s-26e. Such also was the case at Hanford in Kings County. There Standard of California staked 58-8 Mills in 8-19s-22e, about 4 miles southwest of the 5,200-ft. Hanford field.

In Monterey County, The Texas Co. staked location for two wildcats. The 1 Labarere (NCT-3) was under way ¾ mile southwest of San Ardo production, in NE 15-23s-10e. At Pine Canyon about 3 miles south of Kings City, 1 Basham was staked in NE 36-20s-7e.

CALIFORNIA WILDCAT FAILURES

Contra Costa County: Pittsburg area: J. Baldwin, Opr. 1 Baldwin-Soite, 17-2n-1w, dry, TD 5,502 ft., elev. 388 ft.

Fresno County, Coalinga area: M. Pray & E. Walker, Jr. 58 "Well," 19-18s-15e, dry, TD 2,550 ft., elev. 1,368 ft.

Los Angeles County, Orchardale area: Western Gulf Oil Co. 1 Unit A, 10-3s-11w, dry, TD 10,089 ft., elev. 214 ft.

Merced County, Turlock area: R. E. Peterson, 1 C. & O., 15-6s-9e, dry, TD 1,300 ft., elev. 103 ft.

Orange County, Anaheim area: Steele Pet. Co. 1 Anaheim Industrial, 3-4s-10w, dry, TD 7,755 ft., elev. 174 ft.

San Louis Obispo County, Cuyama Valley area: Humble Oil & Ref. Co. 1 Federal-R. D. Sawyer, 28-32s-20e, dry, TD 10,619 ft., elev. 4,061 ft.

South San Miguel area: The Texas Co. 1 Jensen NCT 1, 19-25s-12e, dry, bottomed in granite, TD 4,909 ft., elev. 831 ft.

Santa Barbara County, Cuyama Valley area: Richfield Oil Corp. C-4 Russell, 3-10n-27w, dry, TD 5,045 ft., elev. 1,918 ft.

Ventura County, Cuyama Valley area: R. L. Parris & L. L. Curyea 32 Curyea, 25-9n-23w, dry, TD 550 ft., elev. 4,325 ft.

CALIFORNIA SUCCESSFUL WILDCATS

Kern County, ¼ mile northwest extension to Belgian Anticline field: Union Oil Co. 84-24 CCMO, SE NE 24-30s-21e, flowed 984 bbl. per day, from Oceanic sand at 6,513-6,222 ft., 34.7°-gravity crude, 20/64-in. bean, TD 6,227 ft., elev. 1,576 ft.

New field discovery in Temblor Range area: Canon Drilling Co. 1 Elk Horn, NE SE 27-32s-22e, pumped 10 bbl. per day, 25°-gravity crude, from 580-750 ft. TD 780 ft., elev. 2,529 ft.

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Los Angeles County, new fault block pool and ¼-mile southeast extension to Long Beach field: The Texas Co. 1 Gilbert Brown, 28-4s-12w, pumped 20 bbl. per day 30°-gravity crude and 100 bbl. water from perforations at 7,400-8,275 ft. TD 8,535 ft., elev. 37 ft.

Oklahoma

Washita County Wildcat Opens New Hoxbar Pool

HELMERICH & PAYNE, INC., has a new Hoxbar granite wash discovery well at its 1 Britton, C NE NE 28-9n-17w, 3½ miles south of Cordell, Washita County, in western Oklahoma. With casing perforated at 7,982-92 ft. and formation treated with 500 gal. of wash acid and 500 gal. of mud acid, the well kicked off, after swab was run once, and flowed at an estimated rate of 50 to 100 bbl. of oil and 2,000,000 to 3,000,000 cu. ft. of gas per day. Completion is being delayed pending installation of special equipment to handle the oil, which congeals at a temperature of 40° F. Drilling rig has been moved off. As previously reported, the well had been drilled to a total depth of 8,428 ft. in the Springer zone, topped at 8,060 ft. The Springer section proved unproductive and hole was plugged back and casing run to 8,055 ft. for the present tests.

Already virtually assured of making a good producer in the Bromide sand zone logged at 9,233-9,310 ft., Woodward & Co. and Mendota Oil Co. 1 Connor, deep wildcat test in the NE SE SW 11-7n-3w, 1½ miles north of Washington, McClain County, has found additional indications of good production in the deeper Tulip Creek sand, topped at 9,567 ft. A 20-minute drill-stem test in this pay at 9,572-91 ft. got an oil flow although no estimate of productivity was given. With hole deepened to 9,634 ft., a second test was attempted, taking in the interval below 9,596 ft., but the tool plugged after being open only 8 minutes. However, more than 3,800 ft. of oil was recovered in the breakdown. Hole is being cored deeper in the lower Simpson series.

Pure Oil Co. has put its Beaver County wildcat, 1 Albert, SE SE SW 16-5n-26eCM, on the pump for completion tests of its Morrow sand pay zone, opposite which casing is perforated at 6,018-27½ ft. During one run, lasting 16¾ hours, the well pumped 60 bbl. net oil with 189 bbl. of water. Located 3 miles northwest of Knowles in the northeastern part of the county, this prospective new pool-opener is more than 16 miles northeast of the Beaver-Panhandle pool, the county's first oil production, opened last December by Flynn Oil Co. Pure's well has been undergoing a long series of tests of various horizons from the Arbuckle (total depth 9,233 ft.) up the hole to the present producing zone.

Producing from both the Hart and Springer sands, Phillips Petroleum Co. 1 Denson, SW SW SW 18-3n-3w, new oil discovery well located 3 miles west of development along the Golden Trend in Garvin County, flowed initially 125 bbl. of clean oil in 24 hours through ¼-in. choke. On a later gage through ½-in. choke, it produced 105 bbl. in 24 hours. Tubing pressure was 50 psi. and casing pressure 400 psi. Hart sand is perforated at 8,586-8,632 ft. and Springer at 9,487-9,513 ft. and 9,531-57 ft. Springer sand previously had produced in only one other well, Vickers Petroleum Co. 1 Parks, located 3 miles to the south in the SE NW SE 6-2n-3w. The latter well was completed late last year as the discovery producer of the Southwest Purdy field.

An-Son Petroleum Corp. is opening a new productive area a mile south of the Velma field, Stephens County, at its 1 Prichard, SW SW SW 4-2s-4w. Production is from the second lower Fusilinid sand, opposite which casing is perforated at 4,098-4,111 ft. After recovering load oil, the well flowed 168 bbl.

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OKLAHOMA SUCCESSFUL WILDCAT

Pawnee County: W. B. Moran 1 Canfield, NE SW NE 21-22n-7e, pumped 72 bbl. 33°-gravity oil from Simpson sand 2,975-82 ft., TD 3,202 ft. (New pay in E. Blackburn pool).

OKLAHOMA WILDCAT FAILURES

Choctaw County: The California Co. 1 Stevenson, SE SE SE 31-6s-14e, TD 1,634 ft. (Strat Test).

Comanche County: Aladdin Petroleum Co. 1 Schettler, C NE NE 9-2n-9w, dry, TD 8,372 ft.

Jefferson County: Roy M. Johnson 1 Burton "B," SE NE NE NE 31-3s-4w, dry, TD 2,722 ft.

Kay County: Harper-Turner 1 Schussler, NE NE NW 3-28n-2e, dry, TD 4,017 ft. Helmerich & Payne, Inc., 1 Hammon, SE SW NE 29-29n-3e, dry, TD 3,718 ft.

Kiowa County: Stanolind Oil & Gas Co. 1 Lucy Sallee, NE NE NE 5-7n-16w, dry, TD 9,500 ft.

Lincoln County: William Snakard 1 Beleele, NW NW SW 7-13n-3e, dry, TD 5,385 ft. Deep Rock Oil Corp. 1 Hamner, SE NW NE 12-15n-2e, dry, TD 5,342 ft. Harper-Turner 1 Homer, SE NE SW 20-16n-6e, dry, TD 3,552 ft.

Love County: Fleet Oil Corp. and Ryan Oil Co. 1 Bourland, NE SE NW 12-6s-1e, dry, TD 1,994 ft.

Okfuskee County: Zephyr Petroleum Co. 1 E. Curry, NE SW NE 32-12n-8e, dry, TD 3,774 ft.

Pawnee County: Swift Bros. 1 Hatcher, E½ NE 18-20n-8e, dry, TD 2,790 ft. F. B. Murta 1 Brensing, NW NW SE 29-22n-6e, dry, TD 3,342 ft.

Tillman County: Emmett Long et al 1 Barnes, SW NW NW 11-2s-15w, dry, TD 1,285 ft.

Appalachian-Ohio

Rank West Virginia Reports Good Gas Show

PITTSBURGH.—In Roaring Creek district, Randolph County, West Virginia, Nollem Oil & Gas Corp. 1 Goff-Arnold Land Co., rank wildcat, elevation 2,751 ft. is drilling at 2,204 ft. with gas testing 300,000 cu. ft. Harts Creek district, Lincoln County, United Fuel Gas Co., 6868 Fee, resulted in 2,711,000 cu. ft. gas in the Brown shale, TD 3,555 ft. Big Creek district, McDowell County, Godfrey L. Cabot, Inc., 57-1359 Pocahontas Land Corp., 1,845,000 cu. ft. gas, Berea sand, TD 4,542 ft. Jefferson district, Nicholas County, Columbian Carbon Co., 5-1177 Federal Coal Co., gaged 1,309,000 cu. ft. gas Maxon sand, TD 1,893 ft. Portland district, Preston County, Hope Natural Gas Co., 9673 Nina Kay, elevation 2,296 ft. is drilling in the Oriskany sand at 5,671 ft. which was reached at 5,670 ft.; The 9676 Sarah J. Creamer, elevation 2,097 ft. topped the Oriskany sand at 5,243 ft., has gas testing 379,000 cu. ft. at 5,244-5,255 ft. and is drilling 5,370 ft.; The 9694 Leonie Burrows, elevation 2,061 ft. Oriskany sand 5,273 ft. gas 5,274-5,405 and 5,413 ft. drilling 5,485 ft.

Pennsylvania.—Unity Township, Westmoreland County: People Natural Gas Co. has made a new deep, wildcat location, 4008 J. R. Frola, elevation 2,146 ft. Donegal Quadrangle 1.31 miles south of latitude 40° 15′ and .95 mile west of longitude 70° 20′. This location is on a line between the Piper and Musnug wells. The A. J. Dotterway elevation 2,094 ft. in this area is drilling at 6,697 ft. Somerset Township, Washington County, Furman Nuss et al 1 Sarah C. Knox gaged 2,500,000 cu. ft. of gas, Big Injun sand.

Maryland.—Garrett County: Eberly & Snee 3 Eli Beechie, elevation 2,447 ft.,

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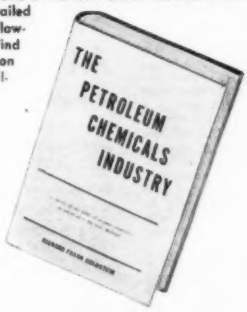

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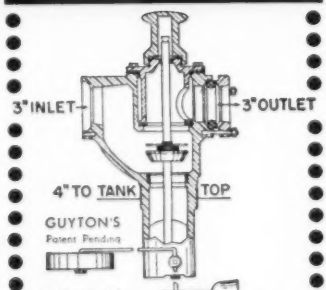

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reached the Chert at 4,076 ft., and drilling is at 4,150 ft.; W. H. and A. A. Rader 1 Evangelical Church, elevation 2,419 ft., chert 3,679 ft., drilling at 3,689 ft.; Fox & Trimble 2 McGee, elevation 2,407 ft., shut down at 4,038 ft., Oriskany sand 3,963 ft., show gas 3,862 ft., water at 4,038 ft.; Heath 1 H. C. Gibson, elevation 2,414 ft., topped the chert at 5,587 ft., and shut down at 3,603 ft., to run casing.

OHIO

In Flint Ridge pool, the Mid East Oil Co. 2 J. E. McCracken, Section 9, Hopewell Township, Licking County, logged Clinton sand at 3,065-3,117 ft., with a fairly good showing of oil natural that increased to 70 bbl. in 24 hours after shot.

Ditch and Gerig 1 Earl Roose, Lot 22, Montville Township, Medina County, offsetting an old low pressure well, found an uptapped gas lens. The well gaged 200,000 cu. ft. natural and shut in after shot at 475,000 cu. ft. with 1,050 psi.

Several wells have started drilling or are ready to start in Putnam field in widely scattered locations. The Mid East Oil Co. is drilling the 1 Nellie Riddle Consolidation in Section 8, Decatur Township. James J. Shearer et al are moving in on the Fred Beebe (Farley) in Lot 29, Watertown Township.

Rocky Mountain

Big Horn Basin Reports New Deep Discovery

DENVER.—Gulf Oil Corp. has a new deep discovery in the Big Horn basin, following drill-stem tests in the Phosphoria at the Worland Prospect wildcat. The well is 1 Stockham Federal, C SE NW 2-46n-94w, southwest of Worland field where production is from the Frontier and Phosphoria zones. The Phosphoria was topped in the Gulf well at 12,910 ft. and on drill-stem test 12,885-12,933 ft., tool open 3 hours, there was a good air blow in 30 minutes with gas at the surface in 2 hours 20 minutes. Flow was an estimated 75,000-100,000 cu. ft. daily and the recovery was surprising in that there was hydrogen sulfide in the gas, whereas, that at Worland proper carries a high hydrogen sulfide content. The operator pulled 28 stands of the pipe and a gas pocket blew some water and distillate from the drill pipe. A total of 1,050 ft. of high gravity distillate, which showed sulfur content, was recovered on the test. Flowing pressure was 1,940 psi. and shut in pressure 4,500 psi. Gulf is coring ahead in the formation.

The C. H. Murphy, Jr., 1 Unit, C SW NE 2-28n-51e, discovery at East Poplar, Roosevelt County, Montana, flowed at the rate of 650 bbl. of 42°-gravity oil daily from the Madison zone and 300 bbl. of oil daily from Charles and may be the first dual completion for the Williston basin. The well was plugged back and has been undergoing a series of tests through various sized chokes from these formations. The well is the fourth discovery in the Montana portion of the basin and the sixth in the U. S. portion of the basin since the Amerada Petroleum Corp. discovery was completed less than a year ago. Murphy is continuing to test on the wildcat, with four new wells being drilled in the area at the present time.

Four new discoveries for the Denver Julesburg basin will continue to increase interest in this area for some time. Ohio Oil Co. made a discovery east of previous production in Cheyenne County, Nebraska. The 1 Cook, SW SW SW 24-15n-48w, made 2,060 ft. of oil and 100 ft. of oil and gas-cut mud in 1 hour on test of the "D" sand between 4,347-57 ft. Ohio is coring ahead for the "J" sand in the well. Roden, Darden and McRae of Denver found oil at 1 Middlemist, NE NE SW 20-2s-57w, wildcat in eastern Adams County, Colorado, for a new discovery on the southern side of the basin. The well made 710 ft. of oil and mud in 1 hour from the zone 5,516-33 ft. S. D. Johnson is running casing for completion of 1 Conockaert, NE NE NW 6-5n-56w, Morgan County, after the well made 1,100 ft. of oil and 30 ft. of oil-cut mud, with 1,100 ft. of fresh water this week. The well was drilled to 5,893 ft., total depth, still in the "J" sand.

In Wyoming a new-pay discovery may be completed at the Brinkerhoff Drilling Co. 8 Midland-Government, S½ SW NE 26-38n-78w, in North Sage Spring Creek field, Natrona County. This well made 1,230 ft. of oil on drill-stem test in the Muddy between 5,021-30 ft. The operator is drilling ahead for Dakota, productive in previous wells in the field.

COLORADO SUCCESSFUL WILDCAT

Moffatt County, Hiawatha: Mountain Fuel Supply Co. 1 Unit, 14-12n-100w, IP 11,000 M.c.f. of gas daily, TD 15,041 ft. PBTD 4,988 ft. Lance(?) 4,885 ft., Lewis 5,550 ft., Mesaverde 5,994 ft., Mancos 8,580 ft., Frontier sand 13,790 ft., Aspen 13,915 ft., Dakota sand 14,098 ft., Morrison 14,235 ft., Curtis 14,625 ft., Entrada 14,725 ft., Cramel 14,795 ft., Nugget 14,811 ft.

MONTANA WILDCAT FAILURE

Yellowstone County, West Acton area: Cities Service Oil Co. 1 McFarland, C SE NE 6-1n-24e, dry, TD 6,454 ft. Madison 5,244 ft., Kinderhook 5,845 ft., Devonian 5,865 ft., Big Horn 6,180 ft., Cambrian 6,408 ft.

WESTERN NEBRASKA WILDCAT FAILURES

Cheyenne County, Southeast Sidney: Ohio Oil Co. 1 P. Lenzen, SW NW SW 11-13n-49w, dry, TD 4,807 ft. 1st. Dakota 4,647 ft., 2nd. Dakota 4,708 ft., 3rd. Dakota 4,764 ft.

Scottsbluff County: William Hanlon 1 Ad-

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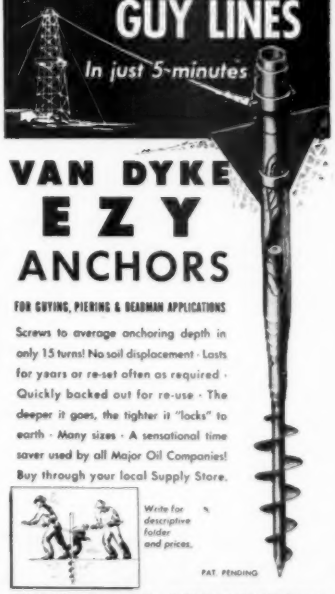

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cock, SE SE NE 3-20n-53w, dry, TD 4,785 ft. Niobrara 3,448 ft., Ft. Hays 3,656 ft., Cordell 3,774 ft., Carlile 3,800 ft., Greenhorn 3,965 ft., "D" sand 4,288 ft., "J" sand 4,437 ft., Skull Creek 4,684 ft.

NORTH DAKOTA WILDCAT FAILURE

Bottineau County: The California Co. 1 Blanche Thompson, SW SW SE 31-160n-81w, dry, TD 8,272 ft. Three Forks 5,365 ft., Jefferson 5,470 ft., Silurian 6,530 ft., Ordovician 7,145 ft., Winnepeg shale 7,860 ft., Winnepeg sand 7,980 ft., Cambrian 8,065 ft., pre-Cambrian 8,245 ft.

Central Area

ILLINOIS

Another new pool is in the making in northeastern Saline County where Bond D. Jones has run casing to test good showings encountered in Cypress sand at his 1 Tom Mahoney, SW SE SW 21-7s-7e, and is starting a confirmation well at a location south. The area is 1½ miles east of the South Broughton McClosky pool, opened last October.

The prospective discovery well logged saturated Cypress sand at 2,676-81 ft., and in a 60-minute drill-stem test got 1,570 ft. of gas and 1,320 ft. of clean oil with a bottom-hole pressure of 1,150 psi. Bottom was still in saturation with no indication of water.

The first confirmation test is 1-B Mahoney, 660 ft. south of the discovery well, in the NW NE NW 28, where rotary rig of Ferbanta Drilling Co. has been moved and now is making hole.

After a long delay due to high water, Carter Oil Co. has completed its Clore sand discovery well, 2 Carroll, NE SW NW 19-4s-13w, on Bull Island, in the Wabash River (Illinois-Indiana boundary line), 3 miles northeast of New Harmony. At completion, the well pumped 57 bbl. of net oil with approximately 3 bbl. of water per day. Sand is at 1,867-73 ft. Sand is exposed by removal of an alloy section in the casing string, cemented at 1,923 ft. Hole was plugged back to 1,882 ft. from its original total depth of 3,071 ft. Location is a mile from nearest production.

Lynch Oil Co. 1 Dave, NE NE SW 27-11n-4e, discovery well of the Shelbyville East pool, Shelby County, pumped 17 bbl. of net oil with 2 bbl. of water at completion in Aux Vases sand at 1,811-35 ft. Total depth is 3,314 ft. Location is about 3 miles southeast of Shelbyville and about 1½ miles south of the Shelbyville pool.

INDIANA

Bury Drilling Co. is confirming its recent discovery of Benoist sand production in the area a mile southwest of Oatsville, in Gibson County. Its 1 W. A. Freeman, SE SW NW 28-1s-9w, north offset to the discovery well, 1 Herbert Rode, produced at the average rate of 7 bbl. of oil per hour while swabbing after a shot of 170 quarts. Hole is open at 1,509-80 ft. with saturated sand at 1,513-19 ft. and 1,560-70 ft. The area is a mile from other production in the Union-Bowman field.

WESTERN KENTUCKY

Production of the Midway pool, 2 miles south of Smith Mills and 3½ miles northwest of Corydon, western Henderson County, has been extended a half mile north by Sinclair Oil & Gas Co. 1 M. D. Eblen, 20-P-21, which pumped and flowed 305 bbl. of clean oil per day at completion. Production is from Cypress sand with casing perforated at 2,613-20 ft. Pay was shot and acidized. Total depth is 2,643 ft. with bottom of the casing at 2,637 ft.

Standard Oil Co. 1 Annie Stewart heirs, McClosky lime discovery well in the Spottsville pool, 2 miles southwest of Spottsville, Henderson County, pumped 168 bbl. of oil per day on completion tests. Pay is at 2,251-56 ft. Previous production in the pool has been from the shallower Aux Vases lime.

EASTERN KENTUCKY

An exceptionally good well for the Big Sandy gas field has been completed by United Fuel Gas Co. at their 6,733 J. S. Kline. Located on Callahan Branch in Pike County the test gauged 10,105,000 cu. ft. of gas daily from Maxon (Mississippian) sand at a total depth of 2,070 ft. A 48-hr. rock pressure showed 530 lb.

An exploratory effort for southeastern Rowan County has ended in failure as Roy Davis et al have abandoned their 1 Coffee at a total depth of 912 ft. in Corniferous lime topped at 816 ft. Test was located 8 miles east of Morehead, the county seat.

First oil for the Artemus gas field of Knox County was recorded as J. W. Smith 1 Spurlock on Moores Creek of Stinking Creek pumped 30 bbl. of oil daily from Maxon sand from 1,550-1,610 ft. total depth.

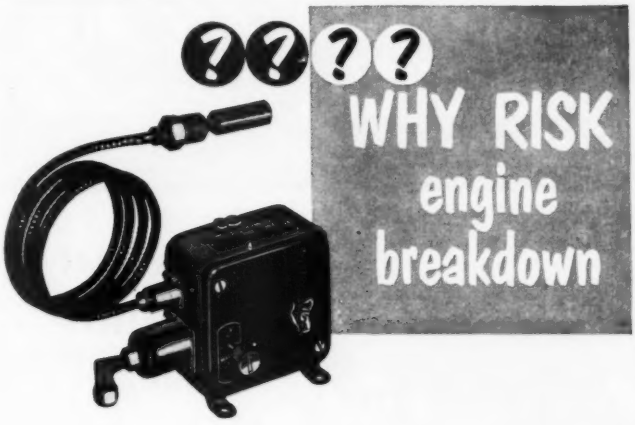
MICHIGAN

Louis Rose had drilled Traverse section at two new Cranberry Lake field wells, with both showing a small amount of free oil in this horizon, and present activity report appeared to indicate that Dundee objective at both wells would be drilled and under test within the next 7 days.

Rose 2 Tope, NW SE NE 1-20n-6w, Winterfield Township, Clare County, logged Traverse lime at 3,134 ft. A show of oil, followed by a large quantity of salt water, was logged at 3,142 ft. Well was being drilled towards the Dundee below 3,200 ft.

Same operator's 1 Blaney SE NW NW 12-20n-6w, logged top of Traverse lime at 3,139 ft. This well likewise carried a show of oil, gas, and 1,000 ft. of salt water at 3,230 ft. Well was being drilled below 3,557 ft.

A new Traverse oil producer in the Rose City Richfield oil pool, Ogemaw County, appeared in prospect a Muskegon Development Co. E-6 State-Foster, NW NW NW 28-24n-1e, Foster Township. Top of Traverse lime was logged at 2,112 ft., and well, on various tests, flowed 60 bbl. logged



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Battery Ignition Applications. Opens battery circuit and sounds an alarm . . . sounds an alarm only . . . opens battery circuit only.

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at 2,112-15 ft., and well, on various tests, flowed 60 bbl. natural in 45 minutes, swabbed 95 bbl. in 6 hours, swabbed and flowed 40 bbl. in 3 hours, and on last report, flowed 30 bbl. of oil in an hour. Further tests of this shallower oil pay were in progress.

ILLINOIS SUCCESSFUL WILDCATS

Shelby County: Lynch Oil Co. 1 Dave, NE NE SW 27-11n-4e, IP 17 bbl., Aux Vases 1,811-35 ft., TD 3,314 ft. (discovery well Shelbyville Fast pool).

White County: Ryan & Sharp 1 Apple, SW SW SW 28-5s-8e, IP 139 bbl., McClosky 3,385-95 ft., TD 3,460 ft. (extension Enfield pool).

E. J. Cunningham 1 Ackerman, SE SW SE 26-4s-10e, IP 106 bbl., Rosiclare 3,021-26 ft., TD 3,115 ft. (extension Phillipstown Consolidated pool).

ILLINOIS WILDCAT FAILURES

Fayette County: R. V. Henderson 1 Carter, SE NW SW 35-4n-1w, dry, TD 1,715 ft.

Jefferson County: The Texas Co. 4 Inland Steel, NE SE SE 31-4s-2e, dry, TD 2,976 ft.

Randolph County: Ralph Halbert 1-A Arnold, S½ NE NW 28-4s-5w, dry, TD 2,387 ft.

INDIANA WILDCAT FAILURES

Dubois County: F. R. Stocker 1 Gutgsell, NE NE SW 8-2s-4w, dry, TD 1,192 ft.

Gibson County: F. B. Drilling Co. 1 Lockwood, SW NE NE 33-3s-12w, dry, TD 1,900 ft.

Jasper County: Charles Davis 1 Ballard, NW NW NW 24-31n-5w, dry, TD 1,020 ft.

Knox County: Ryan & Sharp 1 Waller, NE NE NW 13-1n-11w, dry, TD 1,990 ft.

Posey County: Ryan & Sharp 1 Fuhrer-McDurman, SW NE SW 4-6s-14w, dry, TD 3,084 ft.

Vanderburgh County: M. Rogers and C. Wood 1 Indiana Trust & Savings Bank, SE NW NE SW 18-7s-11w, dry, TD 2,699 ft.

Warrick County: Sunlight Coal Co. 1 Fee (Miller), NE NE SW 25-5s-8w, dry, TD 1,790 ft.

Sunlight Coal Co. 1 Hauselmire, NE NE SW 8-6s-8w, dry, TD 2,564 ft.

WESTERN KENTUCKY WILDCAT FAILURES

Daviess County: F. H. Rhodes 1 Mattox, E½ SW SW NW 19-O-32, dry, TD 823 ft.

Henderson County: Buchman & O'Neal 1 Branson, W½ SW NW NW 22-O-24, dry TD 2,585 ft.

Buchman & O'Neal 1 Bennett, SW SE NW SE 5-P-25, dry, TD 2,422 ft.

MICHIGAN WILDCAT FAILURES

Allegan County, Heath Township: C. J. Trace 1 Lundberg, SW SW NE 29-3n-14w, Traverse 1,387 ft., dry, TD 1,448 ft.

Clare County, Arthur Township: Sun Oil Co. 1 Lower, SW SW NE 31-18n-9w, Marshall 1,579 ft., dry, TD 1,939 ft.

Survey Township: C. W. Collin 1 Smith, SE SE SE 12-17n-5w, Dundee 3,880 ft., dry, TD 3,965 ft.

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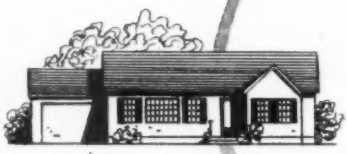

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Kansas

New Producer Indicated For South Nebraska Pool

THE Fischer pool in southern Harlan County, Nebraska, just north of the Kansas line from Phillips County at the northermost extremity of the Central Kansas uplift trend of development, is being revived by a prospective oil producer being completed by Alpine Oil & Royalty Co. and B. & R. Drilling Co. at their 1 Seyler, SE SE SW 33-1n-18w.

The new well, west offset to the discovery well, 1 Fischer, completed in June 1950 by the same operators, and so far the only producer for the pool, is estimated good for 20 bbl. of oil per day after swabbing tests with 1,200 ft. of oil in the hole. Prospective production is from the Lansing lime, opposite which casing is perforated at 3,206-3,304 ft. Top of the Lansing is 3,241 ft. (—1,203 ft.). Total depth is 3,470 ft., plugged back to 3,307 ft. The discovery well was completed from perforations at 3,366-75 ft. with top of the Lansing at 3,228 ft. (—1,201 ft.).

Production of the new Adell Northwest pool in southern Decatur County, northern Kansas, is being extended a location northwest at Continental Oil Co. 2 Gillespie, SW NE NE 34-5-27, now testing various intervals in the Lansing lime, pay horizon of the discovery well. The new producer swabbed 5 bbl. of oil per hour from casing perforations at 3,816-30 ft. Perforated in a higher zone at 3,760-72 ft., it swabbed 48 bbl. per hour for 8 hours. Latest perforations being tested are at 3,718-42 ft. It will be the third producer for the immediate area. The discovery well, 1 Gillespie, NE SE NE 34, completed last January, produces from a series of perforated intervals from 3,632 to 3,820 ft.

Metropolitan Oil Co. has indications of Layton sand production in its 1 B. & M. Farms, SW NW SE 9-33-2e, a wildcat in eastern Sumner County, in the extreme southern part of the state. Approximately 90 ft. of oil-cut mud was recovered in a drill-stem test at 2,607-24 ft. in Layton sand, top of which was logged at 2,600 ft. The prospective pay has been passed up for the time being for a look at lower potential pay zones in the area. The location is 2 miles south of the Lee pool, nearest present production. It is 1½ miles northeast of the abandoned Rutter pool.

KANSAS SUCCESSFUL WILDCAT

Barber County: Nadel & Gussman et al 1 Gypsum, NE NE SE 17-30s-15w, pumped 25 bbl. oil from Viola 4,541-53 ft., TD 4,850 ft. (Opens Turkey Creek, North pool).

KANSAS WILDCAT FAILURES

Barton County: D. R. Lauck 1 Johnson, NE NE NW 6-19s-11w, dry, TD 4,435 ft.

Beordmore Drilling Co. 1 Jurgenson, NW NW NW 16-19s-13w, dry, TD 3,539 ft.

Butler County: J. P. Gaty 1 Bump, NW NE SW 7-27s-3e, dry, TD 3,205 ft.
Ellsworth County: Vickers 1 Staatz, NE NE NW 24-17s-8w, dry, TD 3,385 ft.
Ford County: Deep Rock Oil Corp. 1 Raymond, NW SW NW 21-29s-25w, dry, TD 6,501 ft.
Gove County: C. L. Carlock 1 Coberly, NW NW NW 26-14s-28w, dry, TD 4,468 ft.
Graham County: The Texas Co. 1 Goff, SW SW SE 20-6s-21w, dry, TD 3,830 ft.
Empire - H. Gore 1 Brinkmeyer, SE SE SW 19-8s-23w, dry, TD 4,250 ft.
Hodgeman County: Metropolitan et al 1 Jackson, NE NE NE 20-21s-25w, dry, TD 4,420 ft.
Lyon County: White & Ellis 1 Kipfer, C NW SW 31-21s-11e, dry, TD 2,151 ft.
Norton County: Musgrove 1 Hickert, SW SW SW 25-5s-25w, dry, TD 4,000 ft.
Rice County: Palmer Oil Co. 1 Volkland, NE NE NE 2-18s-10w, dry, TD 3,320 ft.
Stafford County: Buick Drilling Co. 1 Beckerdite, NW NW SE 11-22s-11w, dry, TD 3,600 ft.

Anchor Coupling Opens Branch at Dallas

The Anchor Coupling Co., Inc., of Libertyville, Ill., manufacturers of a line of low, medium, and high-pressure couplings and flexible hose assemblies, has announced the opening of a new branch office and warehouse at Dallas. The warehouse will be completely stocked to serve promptly the hydraulic-hose needs of the oil-field industry with the complete line of Anchor clamp-type and reusable hose assemblies and fittings.

Larkin Packer Sales Force Meets

Sales personnel in attendance at a sales meeting of Larkin Packer Co., Inc., in St. Louis February 3-7 were: G. F. Robinson, Ardmore, Okla.; J. Morrison, El Dorado, Kans.; J. A. Hill, Houston; C. F. Warner, Los Angeles; J. B. Wetsel, Abilene, Tex.; I. P. Allen, Oklahoma City; D. O. Chism, Hobbs, N. M.; J. J. Larkin, Jr., St. Louis; Dorothy Conkin, St. Louis; J. B. Hollingsworth, Houston; W. H. Larkin, St. Louis; R. B. Miller, Liberal, Kans.; A. Hokey, Midland, Tex.; T. E. Alexander, Houston; F. S. Dewel, Casper, Wyo.; F. A. Proctor, Big Spring, Tex.; G. E. Beeman, Victoria, Tex.; W. Ford, Mount Vernon, Ill.; J. Meek, Evansville, Ind.; E. D. Curran, Hoisington, Kans.; J. Brown, Big Spring; T. Michie, Wichita Falls, Tex.; R. L. Ramby, Corpus Christi, Tex.; F. E. Stevens, Laurel, Miss.; B. J. Jostrand, St. Louis; O. L. Wooten, Edmonton, Alta.; F. Cook, Odessa, Tex.; J. C. Green, Shreveport; and P. N. Sullivan, Tulsa.

Cochran to Represent Toledo Pipe Tools in Texas Area

The appointment of Harry C. Cochran as the new sales representative for Toledo pipe tools in the Texas, Oklahoma, Louisiana, and Arkansas area has been announced by Howard A. Mikesell, vice president and sales manager of Toledo Pipe Threading Machine Co., Toledo.

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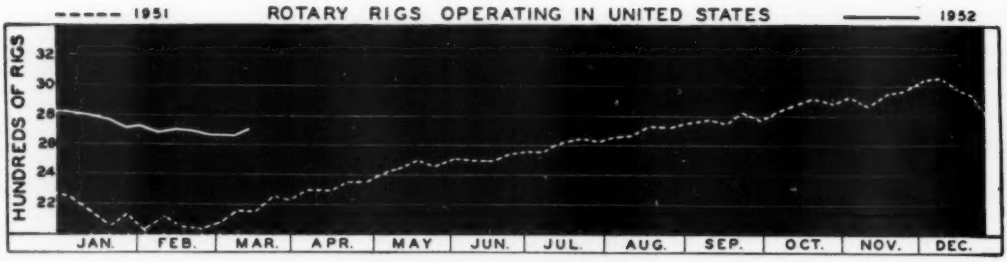
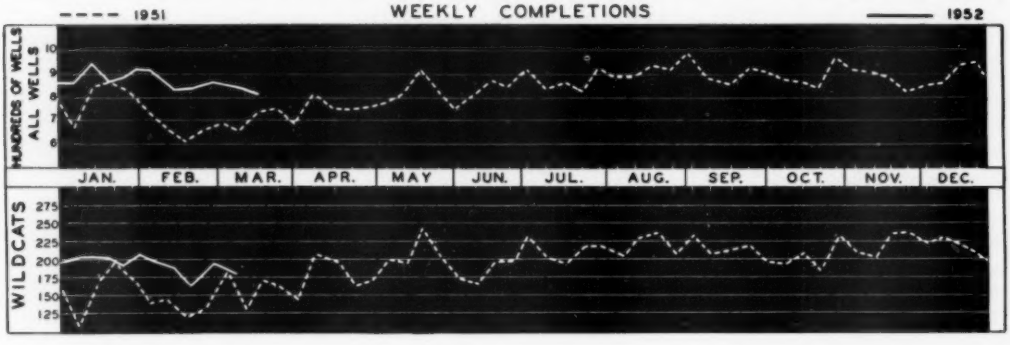




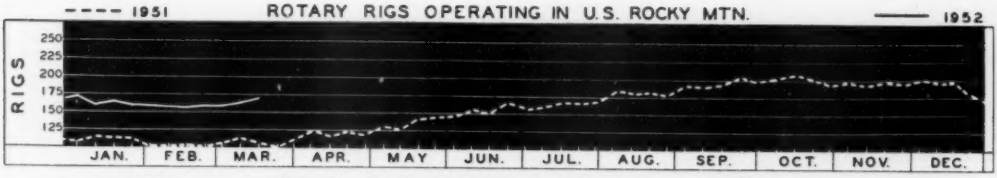
CURRENT STATISTICS

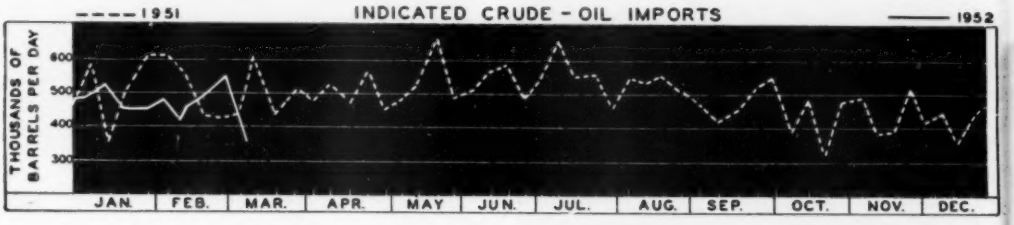
EXPLORATION

WEEKLY WELL COMPLETIONS . . . WEEK ENDED MARCH 15, 1952

	Total of all wells					Mar. 15		Wildcat completions and discoveries										
													Cumulative total, 1952					
	Comp.	Oil	Gas	Dry	Footage	1952	1951	Oil	Dist.	Gas	Dry	Total	Oil	Dist.	Gas	Dry	Total
New York	12	6	0	*6	17,700	99	23	0	0	0	0	0	0	0	0	0	0
Pennsylvania	25	9	4	12	46,200	309	154	0	0	0	0	0	0	0	0	1	1
West Virginia	16	3	13	0	49,304	146	126	0	0	0	0	0	0	0	1	1	2
Ohio	19	6	5	§8	44,538	181	146	0	0	0	0	0	0	0	1	0	1
Indiana	17	5	0	12	33,579	204	192	0	0	0	8	8	10	0	2	70	82
Kentucky	22	7	8	7	54,607	250	154	0	0	0	3	3	7	0	0	40	47
Illinois	21	9	1	11	48,988	301	343	3	0	0	3	6	5	0	0	68	73
Michigan	10	5	0	5	30,180	124	130	0	0	0	3	3	7	0	1	46	54
Kansas	88	48	3	†37	310,689	1,034	812	1	0	0	13	14	21	0	3	171	195
Nebraska	4	2	0	2	19,080	51	63	0	0	0	2	2	2	0	0	29	31
Oklahoma	112	57	5	150	395,952	1,337	1,096	1	0	0	14	15	15	1	6	143	165
Texas	315	199	21	95	1,508,972	3,627	3,223	16	0	2	44	62	160	13	23	796	992
North Central (Dist. 7-B & 9)	107	64	2	§41	336,460	1,132	943	5	0	2	16	23	95	0	8	346	449
West (Dist. 7-C & 8)	105	84	0	21	648,028	1,130	994	4	0	0	14	18	27	0	1	131	159
Panhandle (Dist. 10)	22	9	11	2	64,266	140	151	0	0	0	0	0	1	0	1	14	16
Eastern (Dist. 5 & 6)	15	9	0	6	108,280	185	218	2	0	0	2	4	7	2	0	46	55
Gulf Coast (Dist. 2 & 3)	34	20	5	9	208,556	533	460	4	0	0	3	7	18	7	5	115	145
Southwest (Dist. 1 & 4)	32	13	3	16	143,382	507	457	1	0	0	9	10	12	4	8	144	168
Louisiana	42	31	4	7	285,189	463	416	1	0	1	2	4	9	3	2	47	61
Northern	23	14	4	5	84,578	258	190	1	0	1	0	2	4	0	2	21	27
Southern	19	17	0	2	210,611	205	226	0	0	0	2	2	5	3	0	26	34
Arkansas	3	3	0	0	12,322	72	72	0	0	0	0	0	2	0	0	9	11
Mississippi	8	0	1	7	50,313	90	49	0	0	1	1	2	4	1	1	35	41
Southeastern States	1	0	0	1	6,510	9	12	0	0	0	0	0	1	0	1	4	6
Montana	2	1	0	1	8,363	42	33	0	0	0	1	1	2	0	0	13	15
Wyoming	11	9	0	2	49,583	137	130	0	0	0	0	0	8	0	1	20	29
Colorado-Utah	7	5	1	1	46,976	117	51	0	0	1	0	1	7	0	3	35	45
New Mexico	24	12	9	3	124,731	199	149	1	0	0	2	3	5	0	1	15	21
California	54	45	0	9	220,593	532	388	3	0	0	9	12	24	0	0	99	123
North Dakota	2	1	0	1	16,881	4	0	0	0	0	1	1	1	0	0	2	3
Miscellaneous	0	0	0	0	0	12	7	0	0	0	0	0	0	0	4	2	6
Total United States	815	463	75	277	3,391,250	9,340	7,789	26	0	5	106	137	290	18	50	1,646	2,004
Total previous week	840	467	52	321	3,383,855			35	3	3	139	180	264	18	45	1,540	1,867
Total March 17, 1951	731	401	55	275	2,994,739			30	1	7	136	174	261	15	48	1,330	1,654

Service wells included: *6, †5, ‡3, §1.

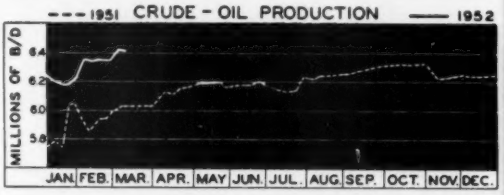


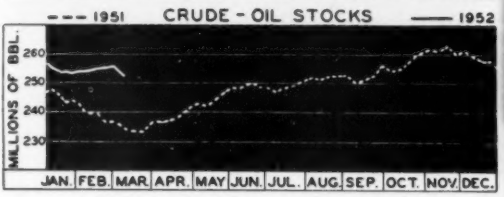


DAILY AVERAGE PRODUCTION FOR WEEK

	March 15, 1952 Crude oil	Lease condensate	Total	Mar. 8 total
Alabama	2,650		2,650	2,500
Arkansas	76,575	4,525	81,100	80,800
California	977,100		977,100	977,400
Colorado	82,700		82,700	81,400
Eastern	57,000		57,000	56,500
Florida	1,750		1,750	1,600
Illinois	164,300		164,300	171,000
Indiana	30,700		30,700	32,700
Kansas	304,500		304,500	313,500
Kentucky	35,100		35,100	35,900
Louisiana	627,875	44,500	672,375	671,575
North	114,150	14,500	128,650	127,850
South	513,725	30,000	543,725	543,725
Michigan	38,500		38,500	36,300
Mississippi	100,650	4,450	105,100	106,375
Montana	23,500		23,500	23,000
Nebraska	6,300		6,300	6,300
New Mexico	161,700	450	162,150	162,050
Oklahoma	522,900		522,900	522,300
Texas	2,910,375	47,700	2,958,075	2,958,075
Dist. 1	33,500	225	33,725	33,725
Dist. 2	166,575	3,875	170,450	170,450
Dist. 3	473,675	27,000	500,675	500,675
Dist. 4	268,750	4,700	273,450	273,450
Dist. 5	62,350	450	62,800	62,800
Dist. 6	126,850	4,600	131,450	131,450
East Texas field	265,000		265,000	265,000
Dist. 7-B	88,500	125	88,625	88,625
Dist. 7-C	140,625	5,925	146,550	146,550
Dist. 8	1,041,250	350	1,041,600	1,041,600
Dist. 9	161,175	450	161,625	161,025
Dist. 10	82,125		82,125	82,125
Utah	4,300		4,300	4,200
Wyoming	182,000		182,000	181,000
Total U. S.	6,310,475	101,625	6,412,100	6,424,475
Change from previous week, down			12,375	
Canada	118,400		118,400	90,750

Total U. S. production January 1-March 15 ..... 472,739,670 bbl.
Same period last year (crude plus cond.) ..... 446,594,050 bbl.



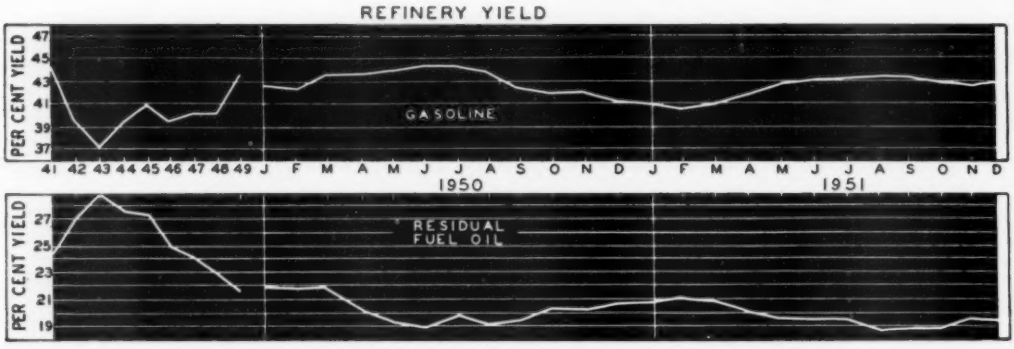


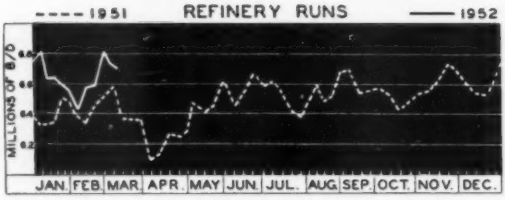
CRUDE-OIL STOCKS BY STATES OF ORIGIN*

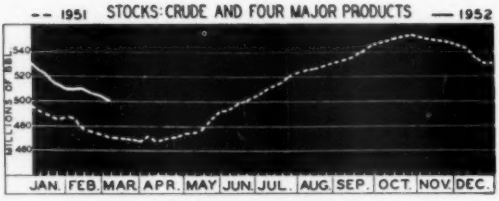
(Thousands of barrels)

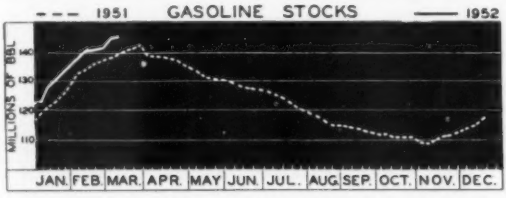
	Mar. 8, 1952	Mar. 1, 1952	Mar. 10, 1951
Pennsylvania Grade	2,261	2,129	2,104
Other Appalachian	2,168	2,135	1,268
Illinois, Indiana, Michigan	11,030	11,463	8,811
Arkansas	2,804	2,791	2,325
Louisiana	13,558	13,594	14,340
North	2,833	2,738	2,934
Gulf	10,725	10,856	11,406
Mississippi	3,459	3,437	2,896
New Mexico	7,663	7,752	6,879
Oklahoma and Kansas	39,607	39,019	37,353
Texas	120,506	122,669	109,743
East Texas proper	10,654	11,191	(†)
West Texas	54,635	55,668	(†)
Texas Gulf	24,939	25,261	(†)
Other Texas	30,278	30,549	(†)
Rocky Mountain	13,596	13,834	12,280
California	30,702	31,184	30,220
Foreign	5,472	6,445	6,320
Total	252,826	256,452	234,539

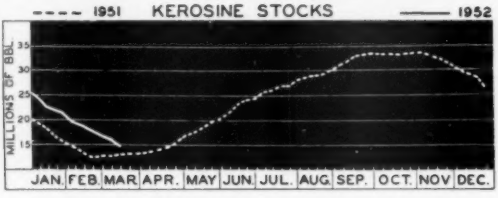
*Bureau of Mines. †Not comparable with current week.

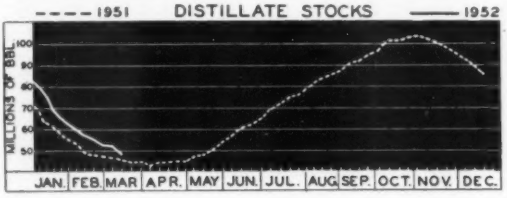


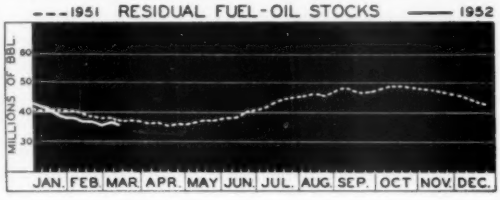










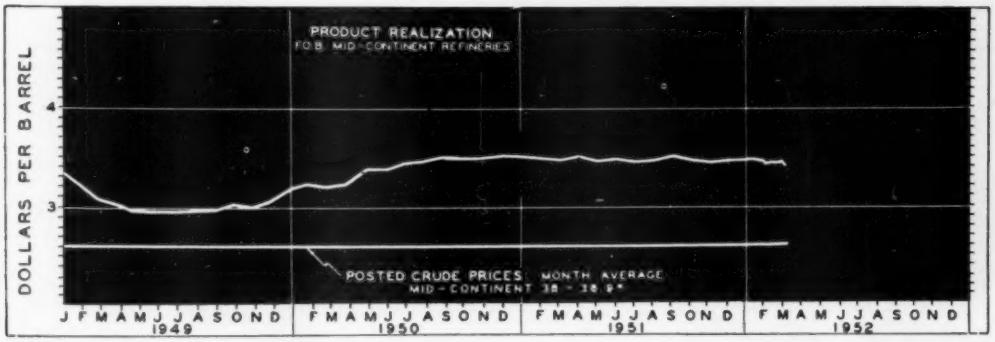


A.P.I. REFINERY REPORT, MARCH 15

(Thousands of barrels)

District--	Daily avg. crude runs	Daily average production				Stocks at refineries, bulk terminals, in transit and in pipe lines				Bureau of Mines, March 1951				
		Gasoline*	Kerosine	Distillate	Residual	Gasoline†	Kerosine	Distillate	Residual	Daily avg. crude runs	Daily average production: Gasoline*	Kerosine	Distillate	Residual
East Coast	1,000	377.6	50.6	254.3	233.7	26,540	5,413	13,000	8,914	1,000	371.6	47.0	245.1	235.6
Appalachian:														
District 1	111	51.0	7.1	18.4	15.6	3,164	283	539	414	101	40.3	7.0	15.0	13.4
District 2	80	39.3	4.7	13.3	24.0	1,389	110	373	132	77	32.8	5.4	10.8	18.2
Ind., Ill., Ky.	1,256	643.6	80.6	228.0	178.1	35,240	3,145	8,125	4,976	1,221	592.5	78.9	226.7	186.3
Okla., Kans., Mo.	564	321.1	14.1	122.3	67.4	17,441	980	6,717	1,258	529	274.0	16.5	126.6	75.1
Inland Texas	229	162.1	13.0	34.4	33.2	5,677	297	1,131	808	237	149.2	15.4	36.7	45.4
Texas Gulf Coast	1,670	747.9	122.3	383.3	264.9	24,906	2,645	7,173	6,239	1,572	688.2	136.0	364.4	274.3
La. Gulf Coast	502	236.1	40.6	160.2	54.7	7,586	1,177	3,408	1,625	486	226.9	65.2	109.1	63.8
N. La. and Ark.	71	27.7	6.7	16.4	4.7	3,163	463	775	152	68	24.8	7.3	17.6	7.8
Rocky Mountain:														
New Mexico	15	8.6		1.3	3.4	147		58	29	13	7.2	.3	2.5	3.2
Other Rocky Mtn	221	103.6	9.6	43.1	48.7	5,652	225	1,256	982	222	103.6	7.5	41.2	47.1
California	974	389.4	3.8	184.9	354.6	15,260	203	5,417	10,525	943	396.5	12.6	131.0	377.3
March 15, 1952	6,693	3,108.0	353.1	1,459.9	1,283.0	146,165	14,941	47,972	36,054	6,469	2,907.6	399.1	1,326.7	1,347.5
March 8, 1952	6,735	3,092.1	372.6	1,469.1	1,317.0	144,956	15,839	49,626	37,087					
March 17, 1951	6,382	2,905.9	375.4	1,256.0	1,353.3	141,007	13,084	44,966	37,753					

*At refineries including natural blended. †Finished and unfinished.


PRODUCT REALIZATION
F.O.B. MID-CONTINENT REFINERIES
DOLLARS PER BARREL
4
3
POSTED CRUDE PRICES: MONTH AVERAGE
MID-CONTINENT 38 - 38.9°
J F M A M J J A S O N D
1949
F M A M J J A S O N D
1950
F M A M J J A S O N D
1951
F M A M J J A S O N D
1952

In this trend chart refinery realization is based on average Mid-Continent grade crude oil (not 38° gravity only) and average prices for refinery products as published in The Oil and Gas Journal basis Oklahoma (Group 3). Refinery yields confined to gasoline, kerosine, distillate, and fuel oil. Realization averaged $3.39 for week ended March 8, $3.42 for previous week, and $3.49 for March 1951. The above trend information is based on volumes and current prices and therefore does not reflect changes in operating costs.

REPRESENTATIVE QUOTATIONS

Representative spot-market quotations of leading suppliers as of March 19, 1952. Figures are f.o.b. plant for tank-car shipments in cents per gallon, except for residual fuel oil which shows the price per barrel and wax, in cents per pound.

GASOLINE, KEROSINE, AND FUEL OILS

	Mid-Continent Group 3	New York Harbor (barge)	Texas Gulf Coast
Regular gasoline, 80-82 octane	10-10¼	12-12.75	10¾-11
Premium gasoline, 86-88 octane	11-11⅜	13.5-13.75	11¾-12
42-44 w.w. kerosine	8⅞-9⅛	10-10.1	9
No. 2 straw fuel oil	8-8¼	9-9.25	8
No. 6 residual	$1.40-1.50	$2.45-2.60	$1.75-1.90

NATURAL GASOLINE

	Group 3	North Texas	N. La.
Grade 26-70	5½	5	5¼
Grade 18-55	6.6	6.1	6.35

LUBRICATING OILS

South Texas

200 vis., No. 2-3 neutral	13-13.5
750 vis., No. 3-4 neutral	16
2,000 No. 5-6 neutral	18-19

LUBRICATING OILS

Mid-Continent

150-160 vis., D bright stock, 0-10 pp.	29
200 vis., No. 3 neutral, 0-10 pp.	16.5-17.5

Western Pennsylvania

145-155 vis., 10 p.t. bright stock	32.5
180 vis., 0 p.t. neutral	31.5

WAX

Mid-Continent

132-134 A.M.P.	5.5

EXCEPT for markets on the East Coast where the volume of petroleum products is influenced by high transportation costs and on the West Coast where military purchases have boosted demand, all products are more readily available than they were in February.

On the Gulf Coast, No. 2 fuel is about the only major product a buyer would have trouble locating. While there have been no reports of cargo offerings, some marketers have indicated that the material can be found. Export demands for distillates from District 3 have been running about 1,000,000 bbl. a month, but this is small compared with monthly production of about 17,000,000 bbl. at refineries on the Gulf Coast.

Very little residual is available for spot purchases along the gulf at the low of the market which is $1.75 a barrel. Low sulfur residual is reported available for prompt lifting at about $1.90, the high of the market.

Increased availability of heavy fuel on the Gulf Coast has been due to the large volume of material moving to tidewater points from inland refineries in Texas and Oklahoma. Considering the general softening of residual on normal northern markets, refiners in north and east Texas have a netback on shipments to the gulf about equal to net realization on any shipments to customers in the normal market areas.

Kerosine and No. 1 distillate fuels are slow moving both on the Gulf Coast and Group 3 markets.

Until the first of March, gasoline at pipe-line terminals in the North Central area was moving to contract accounts except in cases where material subject to demurrage had to be shipped at once. Reported offers of pipe-line gasoline indicate that some of the current movement now may be available for open market trading. In other cases, the marketing areas served from pipe-line terminals have been extended with the greater transportation cost from the terminal to the fringe points covered by reduced netback to the supplier at the terminal.

CRUDE PRICES

GRAVITY SCHEDULE

	Signal Hill, Calif.‡	Oklahoma, Kansas	Gulf Coast Tex.*	West Tex.†
18-18.9	$1.93	....	....	....
19-19.9	1.98	....	....	....
20-20.9	2.03	$2.25	....	$2.13
21-21.9	2.07	2.27	....	2.14
22-22.9	2.12	2.29	....	2.16
23-23.9	2.18	2.31	....	2.18
24-24.9	2.24	2.33	$2.56	2.20
25-25.9	2.30	2.35	2.58	2.23
26-26.9	2.36	2.37	2.60	2.24
27-27.9	2.41	2.39	2.62	2.26
28-28.9	2.46	2.41	2.64	2.28
29-29.9	2.52	2.43	2.66	2.30
30-30.9	2.57	2.45	2.68	2.32
31-31.9	2.62	2.47	2.70	2.34
32-32.9	2.68	2.49	2.72	2.36
33-33.9		2.51	2.74	2.38
34-34.9		2.53	2.76	2.40
35-35.9		2.55	2.78	2.42
36-36.9		2.57	2.80	2.44
37-37.9		2.59	2.82	2.46
38-38.9		2.61	2.84	2.48
39-39.9		2.63	2.86	2.50
40 and above		2.65	2.88	2.52

*For crude from Daboval, El Campo, and Sand Point.

†Includes Lea County, New Mexico. Last general price change represented a 50-cent increase becoming effective December 6, 1947.

‡Standard Oil Co. of California.

FLAT CRUDE PRICES

Representative posted schedules per barrel.

Kettleman Hills, California*	$2.80
Louisiana:	
Beauregard Parish	2.60
Cotton Valley (distillate)	2.85
Cotton Valley (crude)	2.70
Texas:	
East Texas	2.68
Pecos County (Yates)	2.35
Conroe	2.83
Van	2.49
Pennsylvania Grade:	
Bradford	4.25
Southwest Pennsylvania	3.82
West Virginia	3.76
Illinois Basin	2.77

*37°-37.9°

EQUIPMENT MEN . . . in the News

Oil Center Tool Makes Change in Sales, Service

C. T. JONES

FRANK SMITH

In order to provide additional facilities, Oil Center Tool Co. has announced several changes and additions to its sales and service organization, according to Rex E. Galloup, O-C-T sales manager.

C. T. Jones, former salesman in the West Texas district, has been named district manager of the West Texas district.

Frank Smith, former salesman in the West Texas area, has been named assistant West Texas manager and will be in direct charge of the Farmington, N. M., district.

J. C. Norton, formerly in the Alice, Tex., area, has been transferred to Dallas and will be the new district manager for the North Texas and Oklahoma area.

Red Kluck, formerly employed by Spiars Well Equipment Co. and Le-Bus Rotary Tools, has joined O-C-T as a salesman in the West Texas area.

B. G. (Bill) Barefield has been transferred from Houston to the Midland-Odessa area where he will be chief warehouseman in charge of assembly for the West Texas store.

William Delaney, who has just completed a 3-month training program in the Houston shops and office, has been transferred to the Odessa, Tex., branch as a service man.

J. C. NORTON

RED KLUCK

Lufkin Foundry Holds Annual Sales Conference

Lufkin representatives at Lufkin Foundry & Machine Co.'s annual sales conference covering all the oil fields in the United States, Canada, South America, and export office in New York City are, front row: R. C. Thompson, Dan W. Martin, M. L. Wilkinson, L. A. Little, W. W. Trout, A. E. Cudlipp, C. M. Wooten. Second row: D. A. Reid, Jack Gissler, Ben C. Sargent, Jr., E. H. Bounds, Robert Lang, Bayo Hopper, A. V. Simonson, Vernon Glenn, Louis Fincher. Third row: Newell Lynch, Robert Poland, Charles Dyer, W. T. Crowder, Jr., B. C. Burnette, E. P. Trout, V. J. Fawcett, Byron Robbins, J. E. McGranahan, Homer Thrash. Fourth row: Bob Spaulding, A. E. Caraway, Ernest Slaughter, Jr., G. W. Nichols, T. A. Banta, John W. Swanson, Jr., W. H. Miner, Elvin Read, Harold D. Bowerman, L. Carl Frazer, Hubert Dyer, Cooper Richards, T. L. Bowers, Val Gallia, G. L. Vickrey. Top row: W. A. Kirkland, H. H. Muller, Oliver McKay, Edd Terrill, Jr., Lewis W. Breeden, J. Taylor Hood, Jack Read, R. S. Miller, John D. Mettauer, Fred Griffin.

Rockwell Names Andrews District Sales Manager

W. S. Andrews has been appointed New York district sales manager for Rockwell Manufacturing Co.

Andrews received a B.S. degree from University of Pittsburgh. Upon graduation he joined Nordstrom Valve Co. as a salesman, covering western Pennsylvania and eastern Ohio. He was later affiliated with Beaver Pipe Tools, Inc., as Midwest district manager. In 1938 Andrews returned to Nordstrom as a sales engineer with headquarters in Cleveland. He had been Pittsburgh district sales manager for 7 years prior to his recent promotion.

Newton Made Baroid Sales East Texas Superintendent

Paul A. Newton was recently named East Texas district superintendent for Baroid Sales Division, National Lead Co. He will maintain offices in Tyler, Tex., for the firm, which supplies drilling mud products, testing equipment, and related services.

Newton majored in science and mathematics at Upper Iowa University. His experience with Baroid includes work in South Texas and South Louisiana fields. Since March 1951, he had been stationed at Corpus Christi.

Quaker Rubber Names Lewis General Sales Manager

J. R. Lewis has been appointed general sales manager of Quaker Corp., division of H. K. Porter Co., Inc., Philadelphia, it has been announced by T. M. Evans, president of Porter.

Lewis, who has been with Quaker more than 11 years, has successively been Philadelphia district sales manager, assistant sales manager, and assistant general sales manager. In his new position Lewis will be in complete charge of the sales organization of the company.

Changes on Pacific Coast Announced by Schlumberger

F. G. Taves, area manager of Schlumberger Well Surveying Corp., Los Angeles, has announced changes in the Pacific Coast area, to provide expanded activity of the company in California. Two new divisions have been formed within the area. A. H. Curran, Jr., and F. L. Bryan have been appointed division managers.

Curran has been appointed Coast division manager with headquarters in Los Angeles and district offices

A. H. CURRAN, JR.

F. L. BRYAN

C. EDGECOMB, JR.

G. C. HEPBURN, JR.

WILL PLASCH

C. F. GALLAGHER

in Ventura, Long Beach, and Santa Maria. Curran, a native Californian, is a graduate of University of California at Berkeley. He joined Schlumberger in December 1945, working as a field engineer out of the Bakersfield office. In February 1950, he was promoted to district manager at Long Beach, and assumed his present position in January 1952. Bryan, who has been made manager of the newly created Valley division with offices at Bakersfield, was graduated from University of California at Berkeley, joining Schlumberger in 1941. In June 1946 he was made district manager at Coalinga and in May 1950 was promoted to area representative in the San Joaquin Valley.

Serving as Ventura district manager is C. R. Edgecomb, Jr., who joined Schlumberger in December 1943 and was promoted to district manager in March 1948.

G. C. Hepburn, Jr., newly appointed Long Beach district manager, joined Schlumberger in June 1947 after serving in the U. S. Navy.

Will Plasch has been made district manager at Santa Maria. Plasch became a field engineer for Schlumberger in 1946. After active duty with the U. S. Air Force, he returned to the company in 1951 at Ventura, and assumed his present duties in January of this year.

C. F. Gallagher, manager at Coalinga, has been with Schlumberger

ARMOUR KANE

D. G. SWIERS

since 1946, assuming his present position in April 1950.

Armour Kane, Taft district manager, joined Schlumberger in 1943, was transferred from Texas to California in 1950, and promoted to his present position on February 1, 1952.

D. G. Swiers, with Schlumberger as field engineer since April 1947,

C. B. EVANS

J. H. GALLOIS

was made King City district manager on February 1, 1952.

C. B. Evans, Sacramento district manager, assumed his present duties in January 1952, after service since 1948 as field engineer in the Long Beach and Bakersfield districts.

J. H. Gallois, Bakersfield district manager, has had a long and interesting career with Schlumberger. He received a B. S. degree from the Sorbonne (Paris University) and did graduate work in electrical engineering at the Ecole Universelle of Paris. He came to the United States as a member of the Schlumberger organization in 1925, and in 1928 ran some of the first electrical logging surveys

Welex Jet Holds General Sales Meet at Fort Worth

Sales and operating men of Welex Jet Services, Inc., gathered in Fort Worth in February for the company's general sales meeting are, top row: Jack Smith, industrial engineer; Ray Williams, district manager, Hobbs, N. M.; John Sherrod, sales engineer, Midland, Tex.; C. R. (Chick) Parker, district manager, Lindsay, Okla.; George Jefferis, manager of materials; K. L. White, assistant district manager, Odessa, Tex.; Bob Burns, sales engineer, Duncan, Okla.; Joe Wooldridge, sales engineer, Wichita Falls, Tex.; Joe Beard, district manager, Houston; John Flemming, district manager, Corpus Christi; Art Harper, district manager, Wichita Falls; W. O. Foerster, district manager, Falfurrias, Tex.; Ray Porter, assistant manager of materials; E. L. Blackman, division sales manager, Houston; O. B. Avent, district manager, Ardmore, Okla.; L. B. Putman, assistant district manager, Lindsay, Okla. Second row: W. L. Carwile, Jr., division manager, Oklahoma City; W. O. Satterwhite, division manager, Odessa; W. H. Griffin, division manager, Houston; Dr. W. C. Ford, of Psychological Service Institute, Houston, who was speaker at the meeting; R. H. McLemore, executive vice president; T. R. Weymouth, II, secretary-treasurer; Tom Painter, operations manager; Blake Caldwell, chief engineer; A. M. (Bert) Birnie, general sales manager; W. K. Daggett, director of training. Bottom row: R. L. Robinson, research engineer; James E. Staugh, district manager, Kilgore, Tex.; Howard Shireman, sales engineer; R. C. Starrett, assistant district manager, Hobbs, N. M.; Ray Graham, design engineer; H. A. Bergman, sales engineer, Elk City, Okla.; W. B. Clark, assistant district manager, Wichita Falls; R. H. Cossey, district manager, Shawnee, Okla.

ever made. He recently was presented with his 30-year pin, one of the few Schlumberger employes to be so honored.

Calnon Is Made Cummins Vice President, Sales

J. T. CALNON

Promotion of J. T. Calnon from sales manager to vice president, sales, was announced recently by J. E. Everroad, president of Cummins Sales & Service, Inc.

Calnon's sales and service experience includes work as district service manager at Houston and Wichita Falls, division service manager in Odessa, and sales manager in Fort Worth. He will be in charge of Cummins engine sales throughout the company's area of operations.

McCullough Opens Two New Service Branches in Canada

McCullough Tool Co. has announced the opening of two new Canadian service branches at Calgary, Alta., and Regina, Sask., raising the total to three service locations in the rapidly expanding Canadian oil fields.

E. THURSTON

L. M. OAKS

Edwin (Ted) Thurston has been named manager of the Calgary branch. For the past 2 years Thurston has been working out of the McCullough Edmonton service branch as a fishing-tool service engineer.

Loyal M. (Pete) Oaks, a veteran of 23 years in the fishing and drilling business, has been appointed manager of the Regina branch. He has been with McCullough for over 10 years, the last 2 years working out of the Edmonton service branch as a fishing-tool service engineer.

McCullough services now available from three Canadian service locations include: gun perforating; Magna-Tector, for locating stuck point in drill pipe, casing, and tubing; rotary fishing tools; jet bottom-hole cutters; jet casing cutters; jet backoff tools and string shot; junk baskets, and bridging plug service.

D+B Holds Annual Sales Conference

In attendance at D+B conference in Dallas were, back row: J. S. Page, L. G. Evans, JoEarl Morris, W. C. Kinder, J. G. Hast, G. H. Lewis, L. M. Bush. Fourth row: J. A. Long, W. O. Wells, J. A. Francis, R. T. Enloe, W. L. Clowdus, J. W. Mackey, M. H. Miller, J. E. Oster, and J. L. Stanford. Third row: M. E. Moore, W. L. Waddle, R. L. Brower, T. A. Mann, H. L. Jones, W. N. Wells, J. F. Cook, M. A. Lee, A. H. Johnson, E. R. Persons, and R. W. Wildman. Second row: V. L. Lewis, G. W. Mills, J. F. Belk, F. C. Phillips, G. L. Hensley, C. W. Ligon, A. M. Heckler, L. E. Fullingim, and D. E. Walker. Front row: L. L. Thornton, J. M. Guinn, J. D. Poole, D. F. Barton, J. L. Thompson, H. C. Gray, F. D. Turner, T. G. Berryhill, and W. R. Johnson.

D+B Division of Emsco Derrick & Equipment Co. held its annual sales conference in Dallas early in February.

The combined sessions were attended by district managers and salesmen for the California division as well as the Mid-Continent division. The group was conducted on an inspection tour of the new D+B Garland plant where sucker rods and deep well pumping equipment are manufactured.

W. C. Kinder, vice president in charge of D+B Division, presided over the conference, assisted by G. H. Lewis, Mid-Continent sales manager, and L. M. Bush, California sales manager. Highlight of the 2-day session was a dinner attended by executives of Emsco Derrick & Equipment Co. and Continental Supply Co. at which F. I. Brinegar, executive vice president of Continental, was principal speaker. Other speakers included W. T. Powell, executive vice president of Emsco; Dan Bailey, vice president; J. A. Mussler, general sales manager, and C. N. Swanson, director of purchases, all of Continental, and L. G. Evans, Garland, Tex., plant manager.

Other sessions were devoted to 1952 sales program, new and improved D+B products, new plant machinery and equipment, and general sales discussions. John S. Page, president of Page Oil Tools, Inc., Long Beach, presided over a session devoted to Page tension tools.

Schwenk Is Made Blaw-Knox Industrial Vice President

O. G. SCHWENK

W. Cordes Snyder, Jr., president of Blaw-Knox Co. recently announced that Otto G. Schwenk, of Darien, Conn., has been named vice president in charge of industrial products, a new position created within the company. Schwenk will have executive responsibilities connected with the manufacturing divisions of the company.

Schwenk comes to Blaw-Knox from The Yale & Towne Manufacturing Co. where he has been vice president in charge of production and a director. Prior to his association with Yale & Towne in 1948, he was for 4 years connected with the Weatherhead Co., Cleveland, where he served successively as industrial engineer, controller, production manager, and executive assistant to the president. He also served 8 years with a firm of consulting industrial engineers. He will assume his new duties April 1.

Hillman-Kelley Adds Four New Partners

According to a recent announcement by Judson M. Hillman and Markley C. Brown, the Hillman-Kelley organization of Los Angeles has taken into the firm as partners James C. Kelley, William H. Tarver, A. H. Agamenoni, and John B. Isaacs. The four new partners have been employes of Hillman-Kelley for various lengths of time and all have occupied positions of high responsibility.

(Additional Equipment Men in the News on pages 253 and 264.)

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USED rotary and cable tool drilling tools. E. A. Kelly, Box 861, Oklahoma City. Phone 5-6407.

SALES and Rental of Cable Drilling and Fishing Tools, Casing and Equipment from the Southwest's largest stock of used Cable Tools. Degen Pipe & Supply Co., Tulsa, Oklahoma.

FOR SALE: One St. Regis Type 201 FB Valve Bag Filling Machine equipped with guards, solenoid tripping device for cutoff valve. Machine approximately 18 months old and has had very little use. Original cost $2750. If interested call or write Husky Oil Company attention of C. A. Colbern, Box 380, Cody, Wyoming, or telephone Cody, Wyoming, 500.

PIPE FOR SALE

20,000′ 2⅜″ O.D. 4.00# Lapweld Tubing & Rods.
50,000′ 6″ O.D. 10# Lapweld PE Pipe.
50,000′ 6⅝″ O.D. 13# Lapweld Casing T&C.

FRANK MORRIS & CO.
424 So. Cheyenne Phone 2-6247
Tulsa, Oklahoma

Gaso Duplex 4½″ x 6″ Power Pumps with Chrysler C-36 Engines, skid mounted, immediate delivery. Also Byron Jackson, Carter Centrifugal Units. Westinghouse 20-25-50 KW Generating Units.

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Phones: 132—Rockdale, Texas
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Good Used 48-L and 36-L Bucyrus-Erie Drill with or without Tools.

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NEW STEEL PIPE

4″ OD—12 gauge wall
40 foot lengths
Electric Weld
Approximately 15,000 feet
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40 foot lengths
Electric Weld
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EQUIPMENT FOR SALE

FOR SALE: Our Sasakwa Gasoline Plant only, "no field lines" now ready for disposal. Inventory and price available upon request. Cities Service Oil Company, Patridge, Bartlesville, Okla.

USED well drilling equipment. We buy and sell spudders, rotaries, core drills, tools, pipe, blocks, pump jacks, everything for well drilling and service. All used equipment fully reconditioned. Contact us for your requirements and save money. We rent fishing tools. Pressey & Son, Pueblo, Colo.

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FOR SALE

36-L Bucyrus-Erie Spudder, Trailer Type complete tailing in tools for 5″ and 7″ pipe—New 3500′ lines ⅞″ and ¾″—Steel Dog House—Junk Rack—Forge—1500 W Koeler Light Plant—Everything propane equipped. Contact **Herbert H. Hart, 2286WI, El Dorado, Kansas, or Charles V. Cross, 125 Madison, Kansas.**

EQUIPMENT FOR SALE

FOR SALE: Well Drilling Business—71-Star, Modernized #3 Keystone, Both Truck Mounted. Complete Tools, 4 to 20 inch. Physical Inventory $15,000. Nets $6,000 to $8,000 yearly. This is Industrial—No Pipe Worries. Sales Price: $11,000.00. Owner retiring. Write Box E-594, The Oil and Gas Journal, Tulsa, Oklahoma.

THREE Buda Engines 4 cylinder 3⅛″ bore; 4½″ stroke, Model H-173. Brand new and complete less clutch. Cost $640, take $240 each. Box E-669, The Oil and Gas Journal, Tulsa, Oklahoma.

FOR SALE

#1—RECONDITIONED USED LINE PIPE
200,000′—6⅝″ O.D., .280″ wall, 18.97#
300,000′—8⅝″ O.D., .322″ wall, 28.55#
All 20 to 23′ Random Lengths

MECHANICALLY CLEANED AND STRAIGHTENED
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Complete and in good operating condition.
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TOWERS — VESSELS — PUMPS — BOILERS
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Norman Strauss
Phone HArrison 1000

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EQUIPMENT FOR SALE

VALVES: Gate valves from refinery, rising stem 4" each $30, nonrising stem 4" for $25, rising stem 6" each $35, nonrising stem 6" for $50, some other sizes. Also master valves, control heads, pump jacks, upset tubing. Good used equipment. Everything for well service. Pressey & Son, Pueblo, Colo.

MODEL Super H. Fort Worth Spudder, all steel A-mast; D-4400 Caterpillar Diesel; Sand line; 3 drilling cables; 2 drilling stems; 7 bailers; 9'—8'—6' Long bits; Low boy to move machine; 4x4 Chevrolet truck. Fishing tools; Blocks, elevators, and hooks; Light plant, forge, water pump and waterline; all in good condition. James S. Lytle, 216 Ritz Bldg., Tulsa, Oklahoma.

FOR SALE: 723 used Victaulic couplings and gaskets for 6⅝" OD spiral weld line pipe. Price $1.59 each. 256 used Gustin Bacon-Groovagrip couplings and gaskets for 8⅝" OD spiral weld line pipe. Price $2.08 each. The Drillers Gas Company, 24 West 5th Street, Hutchinson, Kansas.

FOR SALE

One six hundred barrel red wood tank—One five hundred barrel—One three hundred barrel gun-barrel and two two hundred and fifty barrel tanks and one one hundred barrel. Also have about three thousand feet of two and three inch pipe for sale. Please call P. C. Dressler, McLouth, Kansas.

FOR SALE

100,000'—6⅝" O.D. #1—13# L.W. Casing
25,000'—5½" O.D. #1—14# L.W. Casing
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100,000 gallon capacity, 34 feet diameter, 20 foot high. In good condition.

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24 & 26" O.D. Steel Pipe

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SUITABLE FOR CULVERTS

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WAbash 2-4911

EQUIPMENT FOR SALE

FOR SALE: Wilson Giant Draw Works with 2-JL-1335 Buda Motors compounded, motors recently overhauled and in A-1 condition. Total price $7,500.00. Glenn R. Nye Drilling Company, Drawer 30, Telephone 897, Hays, Kansas.

FOR SALE AT BARGAIN: Heavy Duty Pumping Unit for handling large volume fluid. Parkersburg J-53-30, double reduction Herringbone gear reducer complete with Buda JL-877 Standard unit with accessories. Motor newly reconditioned. Unit about seven years old but actually in use only short time. First class condition. Now located near Cromwell, Oklahoma. Wrightsman Oil Company, 218 First National Bank Building, Holdenville, Oklahoma.

FOR SALE: 60,000 feet ⅝" sucker rods, in yard ready to load. 4,250 feet ¾" rods. Make me an offer. Call or write Carl H. Schwyn, Cygnet, Ohio. Phone No. 5 or 6.

FOR SALE: EMSCO G-300 drilling rig with 6000' OD drill pipe—6 regular drill collars, 3 F. H. drill collars/EMSCO 96' portable mast/6 ft. steel substructure/7¼" X 12" Gardner-Denver pump—new light plant—all necessary equipment to drill to a depth of approximately 6000'—must be seen to appreciate—this rig in very good condition, priced for a quick sale at $70,000.00 F.O.B. Northeast Texas—Phone #436 Mineola, Texas, or write Box 285, Tyler, Texas.

FOR SALE: Westcott, Foxboro and Emco Gas Meters. George R. Milner, Box 124, Okmulgee, Oklahoma.

7500' OF API Full Hole 4½" Drill Pipe. Graded and tested by Sonoscope engineers. Milford Giffin, Giffin Hotel, Tel. 477, Hoisington, Kansas.

WELL Drilling Rotaries and Spudders, bought and sold. Immediate delivery in most cases. Specify your requirements. Contact Francisco Gonzalez, Baker Export Co., Box 1128, Pecos, Texas.

1 MODEL "K" Cardwell Double Drum Spudder, 145 GK Waukesha Motor. Skid mounted. ⅝" Drilling 9/16" Sand Lines. These lines are 4000'. Tools for 7" and 5½" Hole. Hand Tools Tubing & Rod Tools Complete. Butane Tank, Steel Dog House. This Rig has Folding floor and Roof. Gaines Drilling Co., Box 547, El Dorado, Kansas. Phone 2317.

1 MODEL RL Cardwell Double Drum Spudder with 145 GK Waukesha Motor mounted on Mud Boat. New wire lines, ⅞" Drilling and 9/16" Sand Lines. These lines are 4500' long. Tools for 7" and 5" holes. All Tubing and Rod Tools complete. Big 6 locker Dog House, Butane Tank and Junk Rack. Junk rack also mud boated. This unit has folding walks and Roofs. Canvas goes around unit to house it in for winter. This Unit is complete as far as hand tools and other tools are concerned. Gaines Drilling Co., Box 547, El Dorado, Kansas. Phone 2317.

ROTARY RIG, Wilson Mogul Gardner 7½x10 Pump, 65 Mast, 38 Kelly, 32 DC., Rotary, Swivel, etc., $16,000. Box E-690, The Oil and Gas Journal, Tulsa, Okla.

SHOT HOLE RIG for Sale: Franks K.C. 45 on 1946 Chev. truck. Dodge Water truck, 1951. 200 ft. of drill pipe. Call or write E. E. Hubbard, 1206 N. 11th St., Garden City, Kans. Call 4926.

FOR SALE: 3A National Cable tool machine with JL. 1335 Buda Engine and Youngs Drilling Clutch. Price $5000.00. C. L. Hinds, Box 194, Ulysses, Kansas.

10—8000 GAL. steel 12x10' tanks, vert. open top ¼" plate, have ⅜" plate to enclose end, like new, painted outside, clean and free from rust on inside. Hepperly Equipment Co., 4900 West Madison Street, Chicago, Illinois.

FOR SALE: Wilson Giant Drawworks: 2 Buda JL-1335 Motors with chain compound drive. 1—Code Butane Tank. 4000' 1½" Drill Pipe. May be inspected while drilling 4000' wells near Hays, Kansas. Total price $17,000.00. Powell Drilling Company, 306 Derby Bldg., Wichita, Kansas.

FOR SALE: Wilson Giant Rig complete with 2 250 H.P. Cummings Diesel Engines compound; 96 foot Hi Speed Lee C. Moore Mast; 4000 feet nearly new Drill Pipe; 7¼ x 14 Pump, measuring lines, etc., complete ready to drill. Box E-668, The Oil and Gas Journal, Tulsa, Oklahoma.

EQUIPMENT FOR SALE

FOR SALE: Approx. 3000' of 3½" modified drill pipe, 1 Wichtex Draw-works, 65' mast, 1 17" Oil well Rotary table, 1 C-100 Ideal 6¼" x 10" mud pump complete with motor, 1 PA-100 International Draw-works motor, 1 GMC truck 2½ ton tandem, 1 Ford truck 1½ ton, both oilfield beds & winches. Have all other equip. necessary for complete rig that isn't listed. Rig now working, price, $27,500.00. F. H. Graves, 805 W. Main, Marietta, Oklahoma. Phone 490.

FOR SALE: National Drilling Machine 3A 660, 1947 Model with OCS sand reel, Young drilling engine. Drilled less than 40,000 ft. of hole complete and ready to drill. Cash sale only. Inspection by appointment. Doak & Hughes, Phone 922, Box 568, Bristow, Oklahoma.

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WE BUY well drilling equipment, machines, cable tools, pipe, etc. Turn your surplus equipment into cash. Pressey & Son, Pueblo, Colorado.

WILL PAY highest prices for used casing, used line pipe, abandoned leases, or other surplus lease equipment. Your idle producing equipment is worth dollars. Green Pipe & Supply Co., Box 1383, Tulsa, Oklahoma.

WANTED TO BUY: Used Failing 314C or Failing 1500 drill—send price and full description to Box E-672, The Oil and Gas Journal, Tulsa, Oklahoma.

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GEOLOGICAL and Engineering Library: Last 14 volumes A.A.P.G.—Complete list available upon request. R. L. Geyer, 1815 No. Cheyenne, Tulsa 6, Oklahoma. Ph. 3-9060.

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LONG established small but effective organization in California oil industry desires additional line of equipment preferably in engine or other machinery field. Can function as manufacturer's representatives or dealers. Box E-598, The Oil and Gas Journal, Tulsa, Oklahoma.

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Box E-359, The Oil and Gas Journal, Tulsa, Oklahoma

HELP WANTED

COMPUTER—College degree and two years of experience as Computer and Observer on seismograph crew. To be given intensive training toward position of Party Chief. Write us giving full details of education and experience and salary expected. Geotechnical Corp., Box 7166, Dallas, Texas.

ENGINEERS, Executives, Technical Men. Salaried positions—$3600 to $30,000. This confidential service for outstanding men who desire a change of connection. Will develop and conduct preliminary negotiations without risk to present position. Send name and address for details. Tomsett Associates, 334 Frick Bldg., Pittsburgh 19, Pa.

FOR SOUTH AMERICA: Micropaleontologist. Seismologist. Graduates in Geophysics, mathematics or physics to train as seismologists. Experienced Graduate Drilling Engineer. Experienced Graduate Reservoir Engineer. No fees. Oil Industry Employment Service, 405 Tuloma Bldg., Tulsa, Okla. 4-5974.

KEY Seismograph Personnel Needed by Established and Expanding Seismograph Company. Box E-616, The Oil and Gas Journal, Tulsa, Oklahoma.

HELP WANTED—Experienced landman to head up land department for aggressive integrated independent oil company. Headquarters Houston. Please state age, qualifications and starting salary expected. Address Box E-654, The Oil and Gas Journal, Tulsa, Oklahoma.

PROJECT ENGINEER

A Midwestern nationally known company has an excellent opportunity for an experienced Project Engineer with an engineering education and several years of Petroleum Engineering background. Fluid Catalytic Cracking Plant experience desirable.

This man must be capable of handling a complete job, customer contacts, supervision of layouts and design, selection of equipment and supervising other personnel assigned to a Project.

In applying furnish a complete detailed resume of your experience, background, education, availability and a recent snapshot or photograph.

Salary commensurate with ability.

WRITE BOX E-674

The Oil and Gas Journal, Tulsa, Okla.

HELP WANTED

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EXPERIENCED gravity party chief-supervisor for foreign service. Top salary and expense allowance. Family can accompany. Our personnel have been notified. Apply Box E-660, The Oil and Gas Journal, Tulsa, Oklahoma.

EXPERIENCED surveyors for foreign service with gravity crews. Top salary, subsistence, travel expenses. Our personnel have knowledge of this ad. Apply Box E-661, The Oil and Gas Journal, Tulsa, Oklahoma.

EXPERIENCED seismic personnel interested in domestic or Canadian employment wanted by expanding major contract company. Opportunity for advancement and better-than-average salaries. Box E-673, The Oil and Gas Journal, Tulsa, Okla.

JOBBER SALES ENGINEER

Integrated oil company in Middle West has excellent opportunity for qualified applicant. Position requires at least three years of sales work, preferably in oil industry. College degree in M. E., C. E., or Physics required. Applicant should have knowledge of machinery and internal combustion engines and be willing to travel. Age 28-35. All replies should contain salary required and recent photograph. Box E-680, The Oil and Gas Journal, Tulsa, Okla.

WANTED: Combination Safety Engineer and Metal Inspector. Southwest Refinery. Box E-681, The Oil and Gas Journal, Tulsa, Oklahoma.

NOW READY. List showing where to apply for foreign oil jobs. Write for price. OIML Co., Box 2603, Tulsa, Okla.

REFINERY OPERATORS

Expanding major gulf coast oil refinery has openings for experienced refinery process operators. Progressive company with attractive benefits. Requires 2-4 years operating experience on major refinery units. Good opportunity for experienced Helpers to become Stillmen. Housing available within immediate area. Reply giving detailed experienced, age, education and wage expected. Replies treated confidentially.

Box E-647, The Oil and Gas Journal, Tulsa, Oklahoma

FOREMEN

PRODUCTION AND CONNECTION

Major company has openings in Venezuela for experienced Production and Connection Foremen. Age 40, five years' minimum experience. Working knowledge of Spanish.

WRITE P. O. BOX #35
BOWLING GREEN STATION
NEW YORK 4, NEW YORK

OPPORTUNITIES FOR TECHNICAL REFINERY PERSONNEL for LARGE INTERNATIONAL OIL COMPANY

Entertaining applications of graduate chemical, mechanical, structural and electrical engineers for refinery engineering assignments at home and abroad.

Engineers with refinery experience and also recent graduates will be considered.

Box E-667, The Oil and Gas Journal, Tulsa, Oklahoma

SITUATIONS WANTED

17 YEARS Oilfield Experience—Drilling and Production as well as Technical and Management. Desire connection with stable independent. Prefer Rky. Mtn. area. Box E-635, The Oil and Gas Journal, Tulsa, Oklahoma.

REFINERY MANAGER, extensive experience, desires connection with independent company. Box E-601, The Oil and Gas Journal, Tulsa, Oklahoma.

SUPERINTENDENT or Chief Engineer job, petroleum engineering degree, experience in production and completion work, Age 34. Box E-649, The Oil and Gas Journal, Tulsa, Oklahoma.

ATTENTION: Well established oil well drilling contractor desires to manage and supervise: Individuals', groups', small or medium-sized oil companies' drilling, production and operating problems in Central and Western Texas, and New Mexico Personal interview by appointment is desired. Makin Drilling Company, Box No 1628, Ph. No. 131, Hobbs, New Mexico.

PRODUCTION man, twelve years experience, Drilling Completion, Workover, some secondary recovery. Now employed, desires change. Can give references, 37 years of age. Box E-671, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM GEOLOGIST: Well established, seeks connection with active Independent in West Central Texas area. Retainer or full time basis. Box E-626, The Oil and Gas Journal, Tulsa, Oklahoma.

DO YOU need the services of a petroleum engineer? An experienced engineer desires a good retainer fee to begin practice as a consultant. Box E-682, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM Engineer with several years production experience, desires job where he can get into reservoir engineering work. Box E-683, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED land man's job, especially qualified for work in West Texas. Also, qualified to handle well completion and production. Box E-684, The Oil and Gas Journal, Tulsa, Oklahoma.

M.S. CHEM. B.S. Ch.E. Colloid Chemist, experienced grease manufacture. Box E-685, The Oil and Gas Journal, Tulsa, Oklahoma.

B.S. Ch.E. M.S. Chem. Experienced process engineer natural gasoline and petrochemicals. Box E-686, The Oil and Gas Journal, Tulsa, Oklahoma.

SEISMIC Interpreter - Geologist — Eight years experience desires position with permanent location and opportunity for advancement. Box E-687, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOLOGIST, five years experience, presently employed by major oil company, desires position with smaller, more aggressive company. Box E-688, The Oil and Gas Journal, Tulsa, Oklahoma.

DRILLING engineer, top-designer of Rotary and percussion drilling rigs and tools, possess own not known designs in reverse circulation drilling. 30 years practice, desires connection with serious firm. Box E-675, The Oil and Gas Journal, Tulsa, Oklahoma.

REGISTERED professional petroleum engineer desires position as production superintendent or chief engineer with progressive independent in Mississippi and/or Louisiana. Wide experience in completions, production, workovers, oil field services, secondary recovery. Some experience in rotary and cable tool operations. Presently employed. Box E-677, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOPHYSICIST, eight years seismic experience, desires supervisory position in Rocky Mountain or West Coast region. Employed at present as seis supervisor by major company in southwest. Box E-676, The Oil and Gas Journal, Tulsa, Oklahoma.

PRODUCTION MANAGER. Petroleum Engineer-Geologist. 38. Experienced land and leasing, negotiating drilling deals and contracts, and management drilling and producing operations in Kansas and Rocky Mountains. Desire responsible connection with active and financially sound operator. Box E-679, The Oil and Gas Journal, Tulsa, Oklahoma.

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WILL pay cash instantly for leases (large blocks), royalties, mineral deeds, production. Write fully—P. O. Box 2153, Denver, Colorado.

FOR SALE: Four oil and gas leases in shallow territory, two large leases excellent for water flooding, all in Allen County, Kentucky. Buel Wilson, Box 184, Scottsville, Ky.

CAPITAL immediately available for geologically attractive Drilling Deals, Oil Producing Properties, Producing and Non-Producing Royalties. Send full particulars. Box E-622, The Oil and Gas Journal, Tulsa, Oklahoma.

INVESTMENT funds wanted—From excess taxpayers by independent oil operator. For exploratory well drilling immediately. Geologically favorable. Illinois basin. Box E-569, The Oil and Gas Journal, Tulsa, Oklahoma

WANTED: Producing Oil Royalties and Overrides, Large or Small, Any County, Any State, pay you right off. Wire—Write—Call, Jack Eagle, 311 City Nat'l Bldg., Okla. City, Okla. Phone—REgent 6-7027.

THE American Legion, Department of Texas, offers for lease to the highest bidder mineral rights southeast quarter, Section 31, Block A L and SV RR CO. Survey, Reagan County, Texas. Submit bids to Ralph Holman, chairman, board of trustees, the American Legion, Department of Texas, Suite B-1 Commodore Perry Building, Austin, Texas, on or before noon, Wednesday, April 23, 1952. Board of trustees reserves right to cancel all bids. Attest, G. Ward Moody, Adjutant.

FOR a limited time NEW CAPITAL for operators or for purchase. If you have production and need new "easy term" working capital to refinance obligations, drill more wells, expand, or desire to sell, contact us for details. In reply don't give details—merely state size of lease, number producing wells, daily pipe line runs and whether prorated. Don't sacrifice before you contact us. Box E-624, The Oil and Gas Journal, Tulsa, Oklahoma.

FOR SALE: Oil and Gas Leases and Drilling propositions in Shallow territory of South Central Kentucky. Logs of wells furnished. W. P. Harley, Bowling Green, Ky.

FOR SALE: W. E. Dawes 80-acre lease, two wells producing seven barrels per day. N½ NW 21-19N-5E. Nine miles northeast of Cushing, Oklahoma. Contact Huitt, Deep Rock Oil Corporation.

UINTAH BASIN: 16,000 acres government leases for sale, adjacent huge Major Co. block. Also offer 640 acres, Montana, 116 bbl. settled daily production. 1950 ft. 25 proven locations undrilled. W. H. Smart, 345 Milton Ave., Salt Lake City, Utah.

FOR SALE: Bargain! 70 acre new 10 year lease, Shelby County, Texas, $5 per acre. C. A. Parker, Polley Hotel, Center, Texas.

OFFER 3640 acres, Eastern Kansas, Oil and Gas lease, Arbuckle 1725 feet recommended by geologist. Production Phillips County, Kansas. ¾ interest in 7 wells and ¼ interest in 3 wells, total 3500 bbl. monthly. P. O. Box 733, Topeka, Kansas.

10,000 ACRES on gravity high in South Georgia. I can supply gravity survey map on this acreage to party interested in drilling deal or finance a drilling program. The Tuscaloosa sand has been drilled in Georgia with good oil shows. If's producing in Alabama, why not try Georgia? A good deal to use some tax money with excellent chance for shallow oil and gas production. Gas seepage on good structure. T. R. Davis, 700 Mosley St., Vidalia, Georgia.

NORTH DAKOTA
LEASES and MINERALS

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Evans Opens Tulsa Office For O-T-M Supply Co.

W. C. Evans has opened a division sales office at Tulsa for O-T-M Supply Co., of Houston. O-T-M manufactures and distributes O-T-M Blue Ribbon flanges and other industrial piping. Evans was employed for 10 years by Shell Oil Co. and the Southwest Co. in Tulsa before moving to Houston in 1940.

Evans' experience includes field construction and sales with Bethlehem Supply Co. at Houston; and 7 years with Houston Oil Field Material Co. in a field store, in industrial sales and as a valve and flange salesman for its Briggs Machinery Co. division. He joined O-T-M last September and has spent 6 months in the Houston office.

Besides opening the Tulsa sales office, present plans include building a new Houston plant, to be occupied early this year. The complete facilities of the new plant, buildings, property and increased equipment, are estimated at more than a million dollars.

Midwestern Engine Adds Burtner to Sales Force

H. E. BURTNER

O. E. Murrey, president of Midwestern Engine & Equipment Co., Inc., Tulsa, has announced the appointment of H. E. Burtner to the sales force. Burtner is a veteran of 18 years' experience in the pipe-line and petroleum industries. Thirteen years of this period was spent with the oilfield division of the Gustin-Bacon Manufacturing Co. partly as a branch manager of its Fort Worth office. In 1939 Burtner joined Owens-Corning Fiberglas Corp. For the past 3½ years he has been employed as a salesman for M. J. Crose Manufacturing Co. of Tulsa. Burner's specific responsibility at Midwestern will be in the sales and service of Fiberglas pipe wrap and allied products.

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LEGAL

U. S. DEPARTMENT OF THE INTERIOR, Bureau of Land Management, Washington 25, D. C. Notice is hereby given that two parcels of land in T. 12 N., R. 12 W., La. M., containing approximately 159.62 acres, within the known geologic structure of the De-Soto field, undefined, Louisiana, will be offered for oil and gas leasing through competitive bidding to the qualified bidder of the highest cash amount per acre, at 1 p.m., Eastern Standard Time, on April 30, 1952, when bids will be opened. Details of the lease offering and how and where to file bids may be obtained by addressing an inquiry to this office. Marion Clawson, Director.

LEGAL

U. S. DEPARTMENT OF THE INTERIOR, Bureau of Land Management, Washington 25, D. C. Notice is hereby given that 200.09 acres in T. 35 S., Rs. 29 and 30 W., 6th P.M., Kansas, within the known geologic structure of the East Adams Ranch field, undefined, will be offered for oil and gas leasing, through competitive bidding to the qualified bidder of the highest cash amount per acre, at 1 p.m., Eastern Standard Time, April 16, 1952, when bids will be opened. Details of the lease offering, how and where to file bids, and a description of the lands may be obtained by addressing an inquiry to this office. Marion Clawson, Director.

LEGAL

U. S. DEPARTMENT OF THE INTERIOR, Bureau of Land Management, Washington 25, D. C. Notice is hereby given that four tracts of land totaling approximately 1019.03 acres, in Ts. 129, 130 and 131 N., R. 106 W., 5th P.M., North Dakota, within the known geologic structure of the Cedar Creek field, will be offered for oil and gas leasing, through competitive bidding to the qualified bidders of the highest cash amounts per acre, at 1 p.m., E.S.T., April 16, 1952, when bids will be opened. The details of the lease offering and how and where to file bids may be obtained by addressing an inquiry to this office. Marion Clawson, Director.

LEGAL

U. S. DEPARTMENT OF THE INTERIOR, Bureau of Land Management, Washington 25, D. C. Notice is hereby given that two parcels of land in T. 32 N., R. 82 W., 6th P.M., Wyoming, containing approximately 320 acres, within the known geologic structure of the Iron Creek field, will be offered for oil and gas leasing through competitive bidding to the qualified bidder of the highest cash amount per acre at 1 p.m., Eastern Standard Time, April 23, 1952, when bids will be opened. The details of the lease offering and how and where to file bids may be obtained by addressing an inquiry to the Manager of the Land and Survey Office, Cheyenne, Wyoming, or to this office. Marion Clawson, Director.

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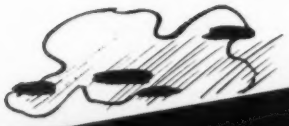

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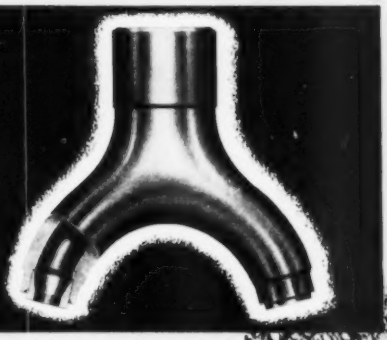

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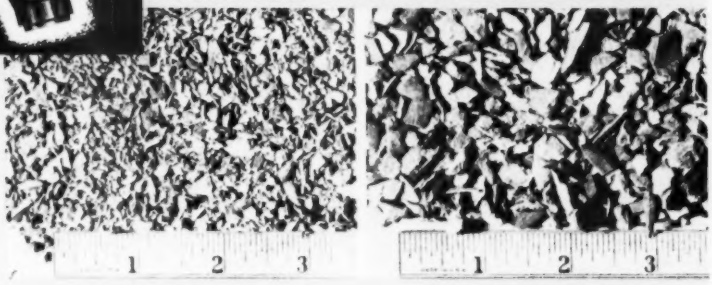

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